PROVISIONAL INTELLIGENCE REPORT

FERROUS METALLURGICAL EQUIPMENT IN THE USSR:

REQUIREMENTS AND SUPPLY

CIA/RR PR-105
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CENTRAL INTELLIGENCE AGENCY

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PROVISIONAL INTELLIGENCE REPORT

FERROUS METALLURGICAL EQUIPMENT IN THE USSR: REQUIREMENTS AND SUPPLY

CIA/RR PR-105

(ORR Project 32.219)

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FOREWORD

This report estimates the amounts of ferrous metallurgical equipment required to support actual or planned iron and steel production in the USSR. It also makes a tentative assessment of the capability of the USSR to equip its iron- and steel-producing plants.

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FERROUS METALLURGICAL EQUIPMENT IN THE USSR: REQUIREMENTS AND SUPPLY*

Summary

The iron and steel industry of the USSR will require about 441,000 metric tons** of nonelectrical ferrous metallurgical equipment in 1955 and about 578,000 tons by 1960. Equipment requirements for new iron and steel capacity will remain relatively stable. Most of the increase in requirements will result from higher replacement needs, which will constitute about 57 percent of the industry's requirements by 1960.

During the Fourth Five Year Plan (1946-50) the USSR failed to meet the plan for the installation of new iron and steel capacity. The production plan for iron and steel was fulfilled, however, because the efficiency of producing units exceeded the expectations of the planners. Gains in efficiency since 1950 have been lower than anticipated, and requirements for new equipment have consequently been higher than planned.

Since 1950 the Soviet heavy machine-building industry has been meeting the requirements for blast furnace and steel furnace equipment, but the requirements for rolling mill equipment have been fulfilled by only 60 to 65 percent. Soviet authorities have attempted to supplement the domestic supply of rolling mill equipment by importing from East Germany and the West. Although rolling mill requirements could be met by Soviet production, the cost would be extremely high because of the shortage of heavy machine-building capacity and the relative inefficiency in the production of some advanced types of rolling mill equipment.

Soviet planners set the 1955 goal for ferrous metallurgical equipment production at 85 percent over that of 1950, but the actual production level for 1951-53 was lower than in 1950. If the requirements

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 November 1954.

** All measurements used in this report are in terms of the metric system.

of the Fifth Five Year Plan (1951-55) are to be met, production must be nearly doubled in a 2-year period. An increase of this magnitude is unlikely unless the USSR drastically curtails other heavy machine-building programs or increases substantially the importation of ferrous metallurgical equipment.

I. Introduction.

A. Definition and Description.

1. Nature of Production and Facilities.

The formulation of a neat concept of a ferrous metallurgical equipment industry would be invalid because there is no group of similar plants producing a fairly well-defined product. The varied types of equipment used in the steel industry cannot all be produced with the same combination of plant facilities. Much of this equipment is produced in multiple-product plants and may constitute only a small proportion of their output.

The heavy machine-building industry produces most of the ferrous metallurgical equipment used in the steel industry. The major characteristics of this industry are as follows:

a. The products are exceptionally large and heavy. Requirements for the equipment demand that they be engineered for strength, durability, and accuracy in operation.

b. The plants must be equipped with large metalworking and handling facilities.

c. High-grade engineering and operating skills are employed.

d. Though the products are used by industrial consumers, the demand for each item is relatively small, and the plants ordinarily use custom or job-lot production techniques.

e. The products are largely specialized.

The structural steel industry also produces metallurgical equipment, fabricating rolled steel shapes and plate for buildings, towers, tanks, cranes, railroad rolling stock, and the like. As in the heavy machine-building industry, production is carried out on a custom or job-lot basis in multiple-product plants.

2. Definition of Ferrous Metallurgical Equipment.

In this report, ferrous metallurgical equipment includes the following kinds of equipment:

a. Nonelectrical machinery for use in the processing departments of iron and steel plants or in the associated departments which supply essential plant services, such as machinery for coke plants, blast furnaces, steel furnaces, rolling mills, pump houses, boiler and power houses, maintenance and repair shops, and the like.

b. Fabricated structural components of iron and steel plant equipment, such as rolled steel shapes, plates, and piping, as well as some cast iron and steel and nonferrous rolled materials. Important components in this category are coke-oven doors and machinery supports.

c. Materials-handling equipment, which includes nonelectrical machinery and structural components of ore unloaders, ore bridges, overhead traveling cranes, charging machines, coke-oven charging lorries, coke pushers, conveyor systems, skip hoists, slag pots, ladles, ingot buggies, and the like.

d. Railroad equipment, which includes locomotives and railroad cars of a special design for transporting hot or cold metal and raw materials.

Specifically excluded from this report are electrical equipment, refractory materials, concrete work, docks, roads, and railroad tracks, as well as buildings and similar structures which are not part of the technical equipment.

The term "iron and steel industry," as used herein, includes plants producing metallurgical coke, pig iron, steel ingots

and steel for castings, rolled steel, steel tube, steel wire, and tinplate. Iron ore mining and ore preparation at mines are excluded. The terms "iron and steel industry" and "steel industry" will be used synonymously. The general term "the equipment industry" covers all plants producing ferrous metallurgical equipment.

B. Administrative Organization.

Until 7 March 1953 the production of metallurgical equipment was under the jurisdiction of the Main Administration for Building of Metallurgical Machinery (Gummash) of the Ministry of Heavy Machine Building. 1/* On that date a new Ministry of Transport and Heavy Machine Building was formed through a consolidation of the Ministries of Transport Machinery, Shipbuilding, Heavy Machine Building, and Construction and Road Machine Building. 2/ On 27 April 1954 this ministry was split, and a separate Ministry of Heavy Machine Building was established under the direction of N. A. Kazakov. 3/ This new ministry probably controls the production of metallurgical equipment.

Other organizations, primarily the Ministry of Construction of Metallurgical and Chemical Industry Enterprises and the Ministry of Ferrous Metallurgy, produce and install some metallurgical equipment. 4/

C. Current Design and Technology.

1. Equipment.

Soviet metallurgical equipment is similar to US equipment but of slightly lower quality.

a. Blast Furnaces.**

In the USSR there are 3 basic types of blast furnace, with volumes of 600, 1,000, and 1,300 cubic meters. They are of modern design, having charging and other auxiliary facilities found in modern US furnaces. In recent years four major improvements have been adopted in Soviet blast furnace manufacture and operation.

* For serially numbered source references, see Appendix E.
** Definitions of technical terms used in this report are given in Appendix A, Glossary of Terms.

(1) The proportion of large, highly mechanized, and automatically controlled furnaces has been increasing. In 1951 they made up 51 percent of the total blast furnace capacity in the USSR, whereas in the US they constituted only 46 percent. 5/

(2) Welded blast furnace construction is replacing riveted construction, saving metal, labor, and construction time. 6/

(3) In Europe and in the USSR, oxygen enrichment of the air blast has been used with good results at several installations, whereas in the US the practice has not progressed beyond the theoretical stage.

(4) Soviet furnaces are being designed for high top pressure, an advanced and more efficient principle of operation. In 1952, Soviet authorities announced that 43 percent of Soviet pig iron would be produced in furnaces equipped with high top pressure, indicating that the USSR had outstripped the US in the development of the process. 7/

b. Martin Furnaces.

The size and automatization of Martin furnaces has been steadily increasing since the advent of the First Five Year Plan (1928-32). In 1951, 36 percent of the total capacity consisted of large, technically perfected furnaces. 8/ Extensive research on oxygen enrichment in the Martin furnace process has been undertaken.

c. Bessemer Converters.

The only significant technical advance in Bessemer operation in recent years has been experimentation with an oxygen-enriched blast.

d. Rolling Mills.

The rolling mills in the USSR are generally patterned after US models. Recently the USSR has attempted to standardize rolling mills and bring about more mechanization and automatization. Continuous mills are rare in the USSR. Possibly 2 are in operation, 1 of them at the Metallurgical Plant in Zaporozh'ye. 9/

2. Trends.

The USSR will probably continue to build large smelting furnaces of modern design. It will continue to stress mechanization, control and standardization, oxygen enrichment, high top-pressure blast furnaces, and highly productive and mechanized rolling mills. Continuous rolling mills may play a more important role.

II. Demand.

A. Equipment Requirements of the Iron and Steel Industry.

1. Methodology.

Equipment requirements of the Soviet iron and steel industry are estimated in this section by means of a variant of the capital coefficients technique. The general procedure used is as follows:*

a. Annual increases in production of the various steel products have been estimated.

b. Increases in production due to greater efficiency have been estimated from Soviet data on increases in the productivity of various steel plant units.

c. Increases in production due to the increased productivity of equipment were deducted from the total increases in production, the remainder being taken as the production from new iron- and steel-producing capacity.

d. Data were collected on the weights and capacities of many types of steel plant machinery from various US and Soviet sources. Coefficients were then derived to represent the ton weight of equipment required per ton of annual capacity to produce each class of product of the iron and steel industry.

e. The estimates of production from new units were multiplied by the proper coefficients. The resulting figures are the estimated equipment requirements in tons.

* See Appendix C, Methodology, for a more detailed discussion.

For most of the equipment, replacement requirements were determined from information furnished by a reliable [redacted]

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2. Estimated Equipment Requirements, 1951-60.

The estimated equipment requirements for 1951-60 are summarized in Table 1.** These estimates are based on the following major assumptions and observations:

a. Requirements are defined as the total aggregate of equipment required to be put into operation in a given year to obtain a given production in that year. Only nonelectrical equipment is considered.

b. Requirements for new capacity are those for completely new producing units.

c. Replacement requirements cover equipment which must be installed to maintain the production of existing equipment. Replacements which alter existing equipment and thereby improve its productivity are also considered in this category.

d. The production of the iron and steel industry is taken to represent capacity, or maximum, production under normal operating conditions.

e. In some cases, US coefficients were used, implying identical technologies in the US and the USSR. The best comparison that could be made between the equipment of the two countries indicates that average capacities of existing Soviet units are substantially below those of the US. The rated capacities of currently produced Soviet units are slightly higher than those of US units for which coefficients were derived.

f. It is assumed that the coefficients of newly installed units will be the same throughout the period studied. In other words,

* For details, see Appendix C.
** Table 1 follows on p. 8.

Table 1

Estimated Nonelectrical Equipment Requirements for the Iron and Steel Industry in the USSR a/
1951-60

Thousand Tons

Type of Equipment	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Requirements for new capacity										
Coke oven b/	9.7	11.1	8.3	9.7	9.7	9.7	11.1	12.5	13.9	13.9
Blast furnace c/	13.5	19.0	15.6	20.8	20.8	20.4	19.7	27.3	26.6	26.0
Steel furnace d/	35.2	20.4	18.1	17.7	24.9	25.1	24.9	29.9	27.2	27.5
Rolling mill e/	99.3	82.1	80.2	72.6	82.1	101.2	93.6	114.6	108.9	107.0
Plant services and miscellaneous f/	86.7	65.5	71.9	63.4	63.4	63.4	63.4	71.9	71.9	74.0
Total	244.4	198.1	194.1	184.2	200.9	219.8	212.7	256.2	248.5	248.4
Replacement requirements										
Coke oven b/	3.5	4.0	4.5	4.9	5.4	6.0	6.4	7.0	7.6	8.3
Blast furnace c/	28.1	31.3	34.8	37.2	40.5	43.6	47.1	50.5	54.5	58.3
Steel furnace d/	41.0	45.4	48.0	50.3	52.5	55.6	58.8	61.9	65.7	69.2
Rolling mill e/	75.5	82.4	88.2	93.8	98.8	104.6	111.7	118.2	126.3	133.9
Plant services and miscellaneous f/	28.6	33.0	36.3	39.8	43.0	46.2	49.4	52.5	56.1	59.7
Total	176.7	196.1	211.8	226.0	240.2	256.0	273.4	290.1	310.2	329.4
Total requirements	421.1	394.2	405.9	410.2	441.1	475.8	486.1	546.3	558.7	577.8

a. Estimated margin of error is plus 10 and minus 30 percent.
b. Based on Tables 16 and 17, pp. 49 and 50, respectively, below.
c. Based on Tables 13, 14, and 15, pp. 45, 47, and 48, respectively, below; includes crushing and agglomerating equipment.
d. Based on Table 22, p. 57, below.
e. Based on Tables 25 and 26, pp. 61 and 62, respectively, below; includes pipe and tube mills and wire-drawing equipment.
f. Based on Tables 28 and 29, pp. 64 and 65, respectively, below.

gains in the productivity of equipment are considered to be the result of improvements in operating units and not the result of changes in the design of new units.

g. The requirements estimates are assumed to be the maximum. If unused capacity exists in parts of the productive processes within some of the divisions of the steel industry, then production may be increased without the installation of complete aggregates of equipment. Furthermore, if increases in the productivity of equipment are greater than assumed, the requirements will be reduced. Small productivity gains have been assumed for 1954 and later years.

B. Valuation of Equipment Requirements.

Although ruble prices are available for a number of ferrous metallurgical equipment items, the costs of only a relatively small percentage of the equipment items are known. The items included in Table 2* are the only ones for which ruble estimates could be made.

All of the ruble prices from Soviet lists are those going into effect on 1 January 1950. They are wholesale prices, f.o.b. the railroad station of origin. No packing, shipping, or erection charges are included.

The prices of coke oven, blast furnace, steel furnace, blooming mill, tube-round mill, pipe and tube mill, and wheel mill equipment were taken directly from Soviet price lists. 11/

The prices per ton of coke oven, blast furnace, and steel furnace equipment were computed as weighted averages of the items included in the price lists. The pieces of equipment which were priced show a wide range of sizes and characteristics, and the weighted prices per ton are therefore believed to be reasonable approximations.

It was necessary to use dollar prices per ton as a basis for valuing mills not included in the list. Table 3** gives the ruble prices per ton for various kinds of rolling mill equipment. The dollar values for 10 types of rolling mills were supplied by a lead-

* Table 2 follows on p. 10.
** Table 3 follows on p. 11.

Table 2

Estimated Value of Selected Ferrous Metallurgical Equipment Requirements in the USSR a/ 1953, 1955, 1957, and 1960

Type of Equipment	Price (1950 Rubles per Ton)	Value (Million 1950 Rubles) 1953	1955	1957	1960
Coke oven	3,550	45.4	53.6	62.1	78.8
Blast furnace b/	5,300	267.1	324.9	354.0	446.8
Steel furnace	5,120	338.4	396.3	428.5	495.1
Rolling mill c/	6,900	1,162.0	1,248.2	1,416.6	1,662.2
Total		1,812.9	2,023.0	2,261.2	2,682.9

a. Based on Soviet 1950 price lists and Table 1, p. 8, above.
b. Includes crushing and agglomerating equipment.
c. Includes pipe, tube, and wire mills.

ing US manufacturer. The dollar values per ton for each type were computed in January 1954 US dollars and an index constructed. The blooming mill price was set equal to 100, since this was the only type for which complete prices were available in both dollars and rubles. With this ruble price and the index of dollar prices, the ruble prices for other mills were computed. The prices for tube-round, pipe and tube, and wheel mill equipment were taken from the Soviet list. The equipment priced by these 2 methods amounts to 96 percent of the rolling mill equipment required. On the basis of these types, a weighted average price per ton was computed.

Until considerable additional research is done and additional price information obtained, it is not possible to determine the prices of steel plant service equipment.

Table 3

Estimated Prices of Selected Types
of Rolling Mill Equipment in the USSR
1950

Type of Rolling Mill	Price Per Ton (1950 Rubles)	Weighting Factor (Percent of Tonnage Required)	Price Per Ton by Weighting Factor (1950 Rubles)
Blooming and slabbing a/	6,550	15.9	104,000
Billet b/	6,550	2.7	17,700
Tube-round a/	6,600	1.0	6,600
Rod b/	10,400	0.8	8,300
Skelp b/	6,350	0.2	1,300
Bar and light structural b/	8,050	26.9	216,600
Plate (including universals) b/	6,900	9.3	64,200
Sheet b/	5,500	11.9	65,500
Rail and heavy structural b/	6,950	15.7	109,000
Wire c/	6,900	4.0	27,600
Pipe and tube a/	6,850	2.5	17,100
Strip b/	6,350	1.3	8,300
Cold sheet and strip b/	7,600	4.1	31,200
Tinplate b/	6,350	0.6	3,800
Wheel a/	2,900	3.2	9,300
Average price per ton	6,900		

a. 12/
b. Computed from the blooming mill ruble price per ton on the basis of the relative dollar values per ton from US data. Dollar values for skelp and tinplate mills are assumed the same as for strip mills.
c. No information available; assumed the same average for other mills.

C. Factors Affecting Rate of Expansion.

Table 4* shows some of the significant relationships which affect the ability of the USSR to carry out expansion plans for the steel industry. The industry requires about 110,000 tons of nonelectrical equipment for each million tons of balanced ingot capacity expansion. In order to support a balanced** production, the industry requires annually about 10,000 tons of replacement equipment for each million tons of ingot capacity.

Gains in productivity have a significant effect on the requirements for new capacity, as was demonstrated in the capacity growth for steel smelting in 1952. Of the total change of 3.1 million tons, about 1.5 million tons were due to the increased productivity of the existing equipment. The entire capacity increase would have required 34,000 tons of new equipment instead of 20,400 tons if efficiency had not improved. Some new investment, of course, was required for the productivity increase. The amount cannot be estimated, but it may be assumed to be significantly less than that for completely new units of equal capacity.

Table 5*** gives the estimated increases in productivity of equipment in the Soviet iron and steel industry during 1951-60. The increases assumed for 1954 and later years are considered to be conservative. They may be much larger, in which case the requirements for new capacity would be reduced accordingly.

Any annual increase in capacity due to new installations naturally increases the equipment requirements, but if capacity additions remain constant from year to year, new allocations of machine-building capacity would not be required. Table 1**** indicates that the total requirements for new capacity will be less in 1952-57 than in 1951. In 1958-60, requirements will be slightly greater than in 1951.

Replacement requirements tend to vary with the size of the stock of capital equipment and the intensity of its use. The replacement requirements of the Soviet steel industry are estimated to increase by 1955 to about 135 percent of the 1951 level, and by 1960 to 193 percent.

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* Table 4 follows on p. 13.

** Balance refers to the proper relative levels of pig iron, steel, and rolled steel.

*** Table 5 follows on p. 14.

**** P. 8, above.

Table 4

Replacement Requirements as a Percentage of the Total Nonelectrical Equipment Requirements for the Iron and Steel Industry in the USSR a/
1951-60

Percent

Type of Equipment	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Coke oven	27	26	35	36	36	38	37	36	35	37
Blast furnace (including crushing and agglomerating)	68	62	69	64	66	67	71	65	67	69
Steel furnace	54	69	73	74	68	69	70	67	71	72
Rolling mill (including pipe and wire mills)	43	50	52	56	55	51	52	51	54	56
Plant services and miscellaneous equipment	25	34	34	39	40	42	44	42	44	45
Total equipment	42	52	52	55	54	54	56	53	56	57

a. Derived from Table 1, p. 8, above; based on tonnage. Estimated margin of error: 1951-55, plus or minus 10 percent; 1956-60, plus or minus 20 percent.

Table 5

Estimated Increases in the Productivity of Equipment in the Iron and Steel Industry in the USSR a/ 1951-60

Year	Increase in Output per Unit (Percent of Previous Year)		
	Blast Furnaces	Steel Furnaces	Rolling Mills
1951	6.7	3.5	5.0
1952	4.4	4.9	5.0
1953	2.1	5.0	4.0
1954	1.5	3.1	3.0
1955	1.2	1.5	2.0
1956	1.0	1.0	1.0
1957	1.0	1.0	1.0
1958	1.0	1.0	1.0
1959	1.0	1.0	1.0
1960	1.0	1.0	1.0

a. Blast furnace and steel furnace figures for 1951-55 from published Soviet data on furnace coefficients of utilization. Other values were arbitrarily assigned. See Appendix C, Methodology.

Replacement requirements are reduced by improvement in the life of equipment through better materials and other measures, but some equipment alterations which increase productivity tend to raise replacement requirements. These factors cannot be estimated but will offset each other to some extent.

The growing importance of replacement in the equipping of Soviet iron and steel plants was shown in Table 4.* By 1960 an estimated 57 percent of the industry's requirements will be for replacement.

* P.13, above.

Total requirements estimates for 1955 are about 5 percent above those of 1951, and for 1960, about 37 percent above those of 1951. By 1955 the USSR will probably have increased its supply of ferrous metallurgical equipment substantially in order to meet the planned production of steel in that year. Because the heavy machine-building capacity is assumed to be fully utilized, the supply of metallurgical equipment could be increased only through (1) reductions in the production of other heavy equipment, (2) increased imports, or (3) expansion of heavy machine-building capacity.

D. Requirements of Other Soviet Bloc Countries for Ferrous Metallurgical Equipment from the USSR.

The USSR supplies an undetermined amount of equipment to other Soviet Bloc countries for the establishment or expansion of their steel industries. East Germany and Czechoslovakia appear to have received none of this equipment, but shipments have been made to Poland, Hungary, Rumania, Bulgaria, and Communist China. 13/ The actual amount of equipment delivered is unknown.

The total requirements of the Soviet Bloc countries can be roughly estimated on the basis of the coefficients developed for the USSR. Excluding East Germany and Czechoslovakia, these requirements would be 85,000 to 95,000 tons for 1953 and 150,000 to 170,000 tons for 1957. These are maximum requirements based on the latest CIA production estimates. 14/ Considerably more data are necessary before firm estimates can be made. The requirements are about 15 to 25 percent of those for the USSR in 1953, rising to 25 or 30 percent in 1957.

Most of the Satellite countries are able to produce at least a part of the equipment needed by their own steel industries, and part of their requirements are probably met by trade with Czechoslovakia and East Germany. The scant evidence available indicates that the USSR is a net importer of ferrous metallurgical equipment.

E. Input Requirements.

The input requirements estimates for Soviet ferrous metallurgical equipment are presented in Tables 6 and 7.* The input information has**

* Tables 6 and 7 follow on pp. 16 and 18, respectively.
** Continued on p. 20.

Table 6

Estimated Material Input Requirements for Ferrous Metallurgical Equipment in the USSR a/*
1953, 1955, and 1957

Thousand Tons

Equipment	Year	Weight of Equipment Required b/	Iron Castings c/	Steel Castings d/	Total Nonferrous Castings and Rolled Items	Steel Forgings e/	Fabricated Rolled Steel f/	Other Input Requirements
Coke oven	1953	12.8	7.23	0.95	0.05	0.36	3.71	0.50
	1955	15.1	8.53	1.12	0.06	0.42	4.38	0.59
	1957	17.5	9.89	1.30	0.07	0.49	5.08	0.68
Crushing and agglomerating	1953	3.6	1.35	0.60	0.01	0.52	0.99	0.13
	1955	4.5	1.69	0.75	0.01	0.65	1.24	0.16
	1957	4.6	1.73	0.76	0.01	0.67	1.27	0.17
Blast furnace	1953	46.8	19.00	12.40	0.33	1.68	10.40	3.09
	1955	56.8	23.00	15.00	0.40	2.04	12.60	3.75
	1957	62.2	25.20	16.40	0.44	2.24	13.80	4.11
Steel furnace	1953	66.1	15.30	24.90	0.79	6.54	17.40	1.12
	1955	77.4	18.00	29.10	0.93	7.66	20.40	1.32
	1957	83.7	19.40	31.50	1.01	8.29	22.10	1.42
Rolling mills	1953	168.4	32.80	70.70	4.21	22.70	37.00	0.84
	1955	180.9	35.30	76.00	4.52	24.40	39.80	0.90
	1957	205.3	40.00	86.20	5.13	27.70	45.20	1.03

* Footnotes for Table 6 follow on p. 17.

Table 6

Estimated Material Input Requirements for Ferrous Metallurgical Equipment in the USSR a/
1953, 1955, and 1957
(Continued)

Thousand Tons

Equipment	Year	Weight of Equipment Required b/	Iron Castings c/	Steel Castings d/	Total Nonferrous Castings and Rolled Items	Steel Forgings e/	Fabricated Rolled Steel f/	Other Input Requirements
Plant services and miscellaneous	1953	108.2	29.10	42.10	1.08	12.10	23.80	
	1955	106.4	28.60	41.40	1.06	11.90	23.40	
	1957	112.8	30.30	43.90	1.13	12.60	24.80	
Total requirements	1953	405.9	104.78	151.65	6.47	43.90	93.30	5.68
	1955	441.1	115.12	163.37	6.98	47.07	101.82	6.72
	1957	486.1	126.52	180.06	7.79	51.99	112.25	7.41

a. Derived from Table 1, p. 8, above, and Table 30, p. 66, below.
b. Weights are all for finished equipment excluding electrical equipment.
c. To determine the raw iron required, divide the finished casting weight by 0.63.
d. To determine the raw steel required, divide the finished casting weight by 0.55.
e. To determine the raw steel required, divide the finished forging weight by 0.80.
f. To determine the raw steel required, divide the finished fabricated steel weight by 0.72.

Table 7

Estimated Services Input Requirements for Ferrous Metallurgical Equipment in the USSR a/*
1953, 1955, and 1957

Equipment	Year	Total Manufacturing Labor (Thousand Man-Hours)	Field Erection Labor (Thousand Man-Hours)	Machine Tool Requirements (Thousand Hours)	Electric Power Requirements (Million Kilowatt-Hours)
Coke oven	1953	2,640	250	320	
	1955	3,110	300	370	
	1957	3,620	340	430	
Crushing and agglomerating	1953	740	70	90	
	1955	920	90	110	
	1957	950	90	110	
Blast furnace	1953	9,660	920	1,160	
	1955	11,720	1,120	1,410	
	1957	12,840	1,220	1,540	
Steel furnace	1953	13,700	1,390	1,660	
	1955	16,050	1,630	1,940	
	1957	17,350	1,760	2,100	
Rolling mill	1953	43,100	5,630	4,520	
	1955	46,200	6,050	4,850	
	1957	52,500	6,870	5,510	

* Footnote for Table 7 follows on p. 19.

Table 7

Estimated Services Input Requirements for Ferrous Metallurgical Equipment in the USSR a/
1953, 1955, and 1957
(Continued)

Equipment	Year	Total Manufacturing Labor (Thousand Man-Hours)	Field Erection Labor (Thousand Man-Hours)	Machine Tool Requirements (Thousand Hours)	Electric Power Requirements (Million Kilowatt-Hours)
Plant services and miscellaneous	1953	40,800	5,990	4,720	
	1955	40,100	5,890	4,650	
	1957	42,400	6,240	4,920	
Total requirements	1953	110,640	14,250	12,470	297.1
	1955	118,100	15,080	13,330	322.9
	1957	129,660	16,520	14,610	355.8

a. Derived from Table 1, p. 8, above, and Table 30, p. 66, below.

been collected from a combination of Soviet and US sources. Appendix C gives the details of the methodology used in the preparation of the table.

Input requirements for 1953, 1955, and 1957 were computed on the same basis, no adjustment being made for changes in productivity of labor or machines.

III. Supply.

A. Location of Production Facilities.

Since World War II, 46 plants in the USSR have produced ferrous metallurgical equipment. The locations of these plants and of eight others which have produced metallurgical equipment previously are shown in Figure 1* and in Appendix B.

Plants producing primarily ferrous metallurgical equipment are in the position of having both their major market and their major raw material supplier in the same industry. If these plants did not serve other industries, they would undoubtedly be located close to steel-producing centers. The locations shown in Figure 1 indicate a two-way orientation of the plants in the industry: toward the old, heavily industrialized areas of Moscow and Leningrad (Economic Regions I and VII**) and toward the centers of the iron and steel industry (primarily, Regions III and VIII).

The Novo-Kramatorsk plant in Kramatorsk and the Uralskiy plant in Sverdlovsk, which are still the giants of the equipment industry, are located in the two largest steel centers of the USSR, the Ukraine and the Urals.

The three important plants*** which began production during World War II are serving new steel centers. 15/ The wartime losses of both steel capacity and heavy machine-building capacity are partly responsible for the expansion in the eastern areas.

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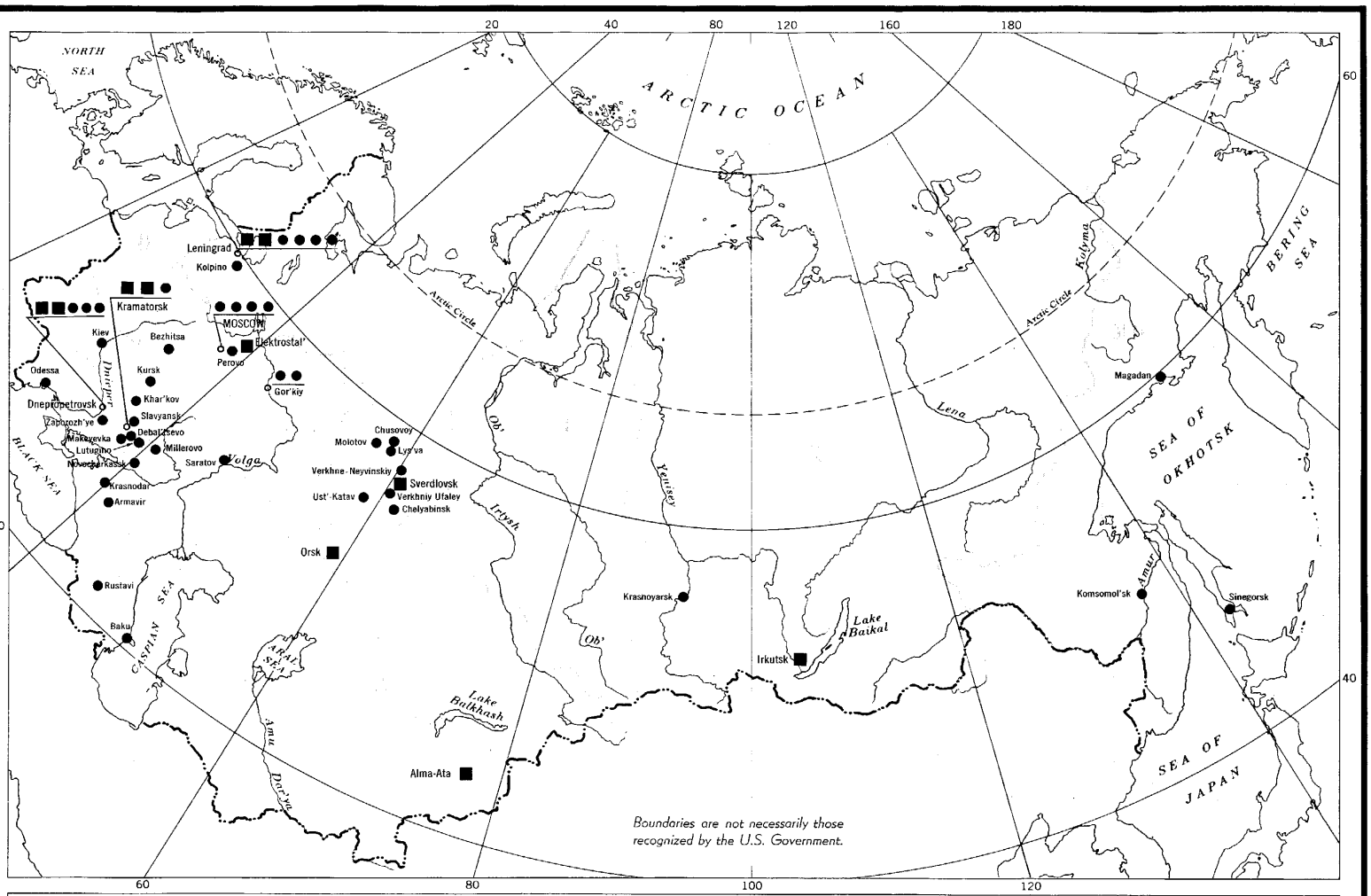
* Following p. 20.

** The economic regions referred to in this report are those defined and numbered on CIA Map 12048.1, 9-51 (First Revision, 7-52), USSR: Economic Regions.

*** Alma-Ata, Yuzhno-Uralskiy, and Irkutsk.



USSR: Ferrous Metallurgical Equipment Plants—1954

■ Major plant ● Minor plant

Economic region boundary

Statute Miles: 0 250 500 1000 1500 2000

Kilometers: 0 250 500 1000 1500 2000

B. Reconstruction after World War II.

The first postwar task of the metallurgical equipment industry was reconstruction of the steel industry. The Fourth Five Year Plan (1946-50) called for the building or reconstruction of the following units: 45 blast furnaces with annual capacity totaling 12.8 million tons of pig iron; 165 open-hearth furnaces, 15 steel converters, and 90 electric furnaces with annual capacity totaling 16.2 million tons of crude steel; 104 rolling mills with annual capacity totaling 11.7 million tons of rolled steel; and 63 coke-oven batteries with annual capacity totaling 19.1 million tons.

Of these totals, 36 blast furnaces, 73 open-hearth furnaces, 14 converters, 16 electric furnaces, and 61 rolling mills were to be reconstructed. 16/ Rebuilding many of the war-damaged units required machinery and fabricated steel equal to new furnace requirements because the units were demolished to the foundations.* The productive capacity of the new and reconstructed units included in the plan equalled 85 to 90 percent of the Soviet iron and steel production in the peak prewar year, 1940.

Between 35 and 50 machine-building plants throughout the USSR contributed to the production of equipment for the reconstruction program. The Uralmash works and the restored Novo-Kramatorsk works at Kramatorsk again became the leading producers in the metallurgical equipment field. In addition to the domestic production, the steel industry received machinery from western countries as regular imports and from East Germany as reparations.

Apparently the plan was not fulfilled by the end of 1950, the most serious delays occurring in the building of new open-hearth furnaces and rolling mills and in the reconstruction of damaged blast furnaces. Even with the external sources of supply, it appears that the construction plan was only 70- to 75-percent fulfilled. The gains in productivity, however, were sufficient to offset the failure of the construction plan, and the production plan for the steel industry was approximately fulfilled.

* It has been estimated that repair of the war damage required 1.5 billion man-hours of labor and that the planned construction work for the steel industry, 1946-50, would require 1 million tons of rolled steel. 17/

C. Domestic Production.

A reasonably complete production record for metallurgical equipment has been pieced together from official Soviet announcements, but metallurgical equipment is not defined in Soviet publications. It is apparent that the category does not include all equipment used in the iron and steel industry and that it also includes some equipment used in the nonferrous metals industries. 18/ The figures in Table 8 and Figure 2* are given only as crude indicators of the direction and relative amount of change in total production of metallurgical equipment.

The data concerning metallurgical equipment in the 1941 Plan indicated that the coverage of the official category was relatively limited. The Plan gave the projected production of metallurgical equipment as 45,000 tons and of spare parts for metallurgical equipment as 193,000

Table 8

Estimated Production of Metallurgical Equipment in the USSR 1940-53 and 1955 Plan

Year	Tons	Index (1940 = 100)
1940	27,800 a/**	100
1941	14,000 b/	50
1942	7,000 b/	25
1943	17,000 b/	61
1944	28,000 c/	101
1945	32,000 c/	115
1946	44,800 c/ d/	161
1947	48,400 d/	174
1948	93,900 d/	338
1949	119,200 d/	430
1950	133,440 a/ d/	480
1951	94,520 e/	340
1952	105,860 f/	380
1953	124,910 g/	450
1955 (Plan)	247,000 h/	890

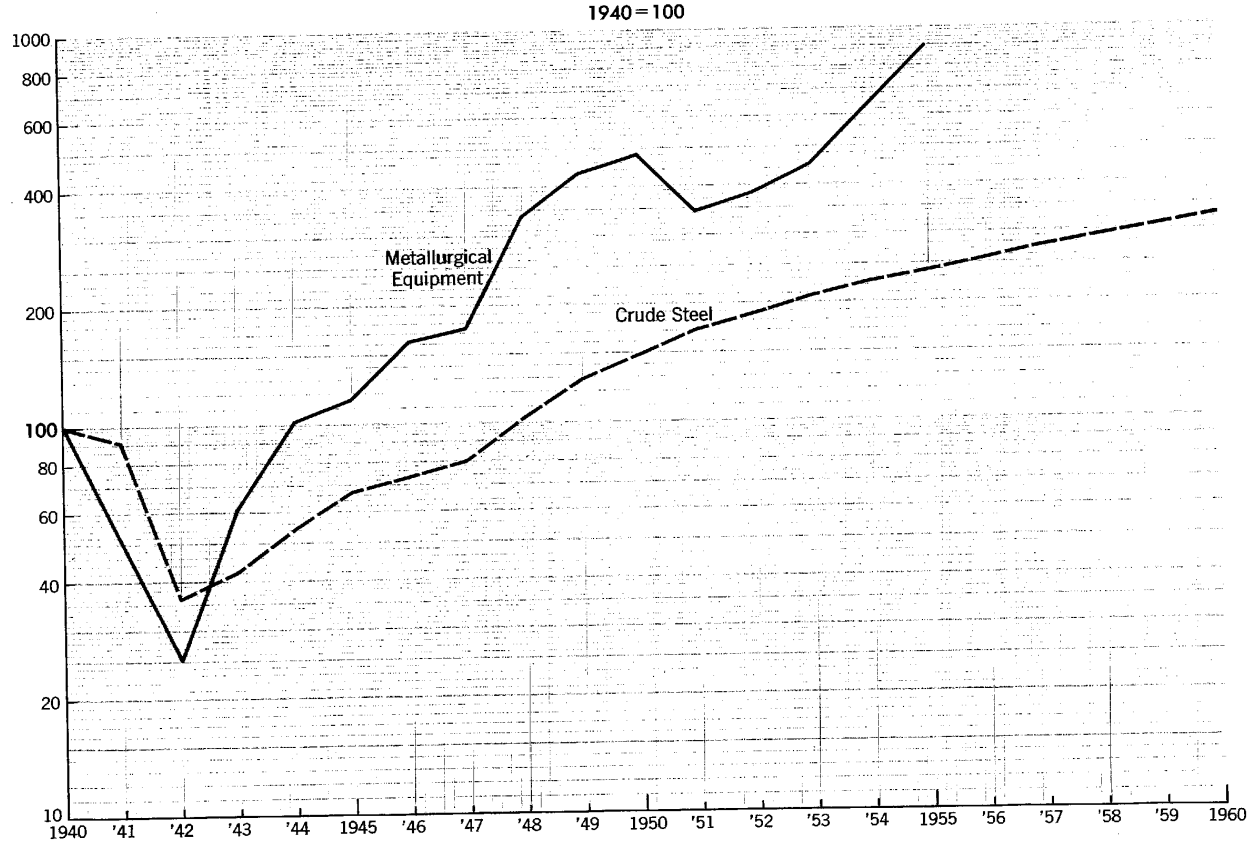
* Following p. 22.
** Footnotes for Table 8 follow on p. 23.

SECRET

USSR

INDEX OF ESTIMATED OUTPUT OF METALLURGICAL EQUIPMENT AND CRUDE STEEL

1940 = 100



13250 3-55

The scale of this chart is semi-logarithmic. It cannot be used to compare absolute levels of output, but rates of growth may be compared. Equal slopes of the two curves between the same years indicate equal rates of growth.

SECRET

Table 8

Estimated Production of Metallurgical Equipment in the USSR
1940-53 and 1955 Plan
(Continued)

a. 19/
b. 20/
c. 21/
d. 22/
e. 23/
f. 24/
g. 25/
h. 26/

tons. Other categories of equipment, most of which are used by the steel industry, are included in the plan: forged and cast steel rolls, 16,100 tons; cast iron rolls, 74,000 tons; coking equipment, 2,000 tons; sintering equipment, 1,200 tons; and crushing equipment for iron, steel, and nonferrous metals, 1,300 tons. 27/ This breakdown leads to the conclusion that the category of metallurgical equipment in the USSR includes only new, specialized equipment for blast furnaces, steel furnaces, and rolling mills.

The production indexes for metallurgical equipment and crude steel plotted in Figure 2 reflect the comparative rates of growth in production of the two commodities. The equipment index is for the production of machinery for new units. The crude steel index is taken as representative of the growth of the entire Soviet steel industry. Indexes for pig iron and finished steel are included with that for crude steel in Table 9.*

It is not feasible to attempt a complete production record of metallurgical equipment based on plant information, because much of the equipment used in any productive or service division of a steel plant may be common to all industries. Furthermore, equipment made of structural steel often leaves the fabricating plant as separate components, taking on the identity of the finished piece of equipment only after assembly at the receiving plant. A blast furnace, for example, is never a blast furnace until the parts are assembled at the erection site.

* Table 9 follows on p. 24.

Table 9

Estimated Production of Pig Iron, Crude Steel, and Finished Steel in the USSR 1940-60 and 1955 Plan

Million Tons

Year	Pig Iron	Crude Steel a/	Finished Steel b/
1940	15.0	18.3	13.1
1941	12.0	16.7	13.0
1942	4.5	6.5	4.5
1943	5.9	7.7	5.6
1944	7.7	9.9	7.0
1945	9.0	12.3	7.9
1946	10.1	13.4	8.9
1947	11.5	14.6	10.3
1948	14.0	18.7	13.2
1949	16.7	23.4	16.7
1950	19.3	27.1	19.5
1951	22.0	31.2	22.4
1952	25.1	34.3	25.1
1953	27.4	37.7	27.6
1954	30.2	40.7	29.8
1955 (Plan)	34.0	43.9	32.0
1955	33.0	43.7	32.0
1956	35.8	46.7	34.2
1957	38.6	49.7	36.4
1958	42.4	53.1	38.9
1959	46.2	56.5	41.4
1960	50.0	60.0	43.8

a. Includes steel ingots and steel for castings.
b. Includes finished hot-rolled steel, steel castings, and steel forgings.

This problem of component parts also makes it impossible to determine production of steel plant machinery by adding items produced in the various plants. There is a strong probability that items will be double counted in such a procedure because the reports cover not

only complete aggregates of machinery but also single machines which will constitute part of an aggregate.

Rolling mills and other finishing mills are more easily totaled because a mill takes on its final identity during manufacture. It should be kept in mind, however, that a report on the completion of a rolling mill does not necessarily imply production of auxiliary equipment such as cranes, shears, heating furnaces, and the like. All of the complete rolling and other finishing mill equipment known to have been produced in the USSR during the first 3 years of the Fifth Five Year Plan (1951-55) are listed in Table 10.* Some of the weights for aggregates are taken from source documents and some from the Soviet catalog of rolling mill equipment or other Soviet sources. 28/ Where the type of mill is stated but no size given, the size is assumed to be the one most commonly mentioned in the Soviet literature. Mills not having specifications or weights in the Soviet sources were assigned the weights of average US mills of the same type. Rated or estimated annual capacities were assigned by the same procedure.

Weights in the "Mill" column are actual or estimated weights of the rolling mills or other main machines. In the column marked "Aggregate" are the estimated weights of the entire complex of equipment required by the mill, including the weights of the main machinery. Only the "Mill" weights can be segregated as part of the official metallurgical equipment category. Other items in the "Aggregate" column may belong in the category, but it is not known what portion of the aggregate they represent. For the period 1951-53 the identified items averaged about 20 percent** of the metallurgical equipment production given in Table 8. By way of comparison, the 1941 plan figure for rolling mill equipment production was 45 percent of total metallurgical equipment.

D. Adequacy of Supply.

1. Before 1950.

The problem of supply must be studied by a combination of both direct and indirect methods. A well-qualified source 29/ states

* Table 10 follows on p. 26.
** In 1951, 38 percent; 1952, 16 percent; and 1953, 10 percent.

Table 10

Complete Units of Rolling and Other Finishing Mill Equipment Known to Have Been Produced in the USSR
1951-53

Date Produced or Date of Announcement	Description	Producing Plant	Customer	Number	Estimated Weight (Tons)		Rated or Estimated Annual Capacity (Thousand Tons)
					Mill	Aggregate	
February 1951	400-mm tube mill	Uralmash		1 or more	3,500	6,000	125 30/
April 1951	Blooming mill	Novo-Kramatorsk, Kramatorsk		1	3,600	5,700	900 31/
April 1951	Rail-structural mill	Uralmash		1	8,000	16,500	720 32/
June 1951	Cold strip rolling mill	Staro-Kramatorsk		1	32	1,400	50 33/
June 1951	Blooming mill	Uralmash		2 or more	7,200	11,400	900 (each) 34/
December 1951	Strip mill	Uralmash	Magnitogorsk Steel Plant	1	2,500	4,000	75 35/
March 1951	Blooming mill	Yuzhno-Uralskiy	Kuybyshev, Kramatorsk Steel Plant	1	3,600	5,700	900 36/
September 1951	Wire-drawing bench	Alma-Ata		1	N.A.	N.A.	N.A. 37/
September 1951	Rail-structural mill	Uralmash		1 or more	8,000	16,500	720 38/
February 1952	Rail-structural mill	Uralmash		1	8,000	16,500	720 39/
February 1952	Tinplate mill	Uralmash		1	N.A.	3,000	N.A. 40/
April 1952	Roofing-sheet machine	Machine Building Plant imeni Kalinin, Kursk	Saratovskaya and Ryazanskaya Oblasts	2	N.A.	N.A.	N.A. 41/
September 1952	Blooming mill		Poland	1	3,600	5,700	900 42/
November 1952	650-mm tube mill	Novo-Kramatorsk, Elektrostal'	Azovstal Steel Plant	1	6,000	10,000	250 43/
November 1952	Heavy rolling mill (type unspecified)	Novo-Kramatorsk, Elektrostal'	Nizhniy-Tagil Steel Plant	1	N.A.	N.A.	N.A. 44/
December 1952	Tinplate mill	Novo-Kramatorsk, Kramatorsk		1	N.A.	3,000	N.A. 45/
August 1953	1,150-mm blooming mill	Uralmash		1	3,600	6,500	1,200 46/
December 1953	1,700-mm sheet mill	Novo-Kramatorsk, Kramatorsk		1	9,000	9,900	650 47/

that the USSR is technically capable of producing all types of metallurgical equipment but that production has been consistently lower than planned.

The available information about productivity indicates that from 1946 to 1950 about 25 percent of the increases in pig iron production and about 40 percent of the increases in crude steel production were the result of higher efficiency. 48/ The plan for production was met in 1950 because of these efficiency increases. An article in Vestnik statistiki 49/ states that during the Fourth Five Year Plan period the Soviet supply of metallurgical equipment was adequate because of qualitative improvements but that the physical quantity of equipment installed was less than planned.* Adequacy of supply because of improvements in productivity has a distinct advantage over purely quantitative adequacy, since smaller resource allocations are necessary to support a given level of production.

2. 1951 and After.

The Fifth Five Year Plan goals are indicated in Table 11.** If the plan had been fulfilled, the additional facilities installed during 1946-50 would have been sufficient without productivity increases. The new capacities in 1955 for pig iron and crude steel plus the 1950 estimated capacities total less than the planned production for 1955. There is excess planned capacity for rolled steel in 1955.

The plan calls for the following percentage increases in 1955 over 1950: pig iron production, 76 percent and new pig iron capacity, 32 percent; steel production, 62 percent and new steel capacity, 42 percent; rolled steel production, 64 percent and new rolled steel capacity, 100 percent.

The smaller increases for new pig iron and crude steel capacities might indicate (a) that there was excess capacity at the end

* This statement appears to be at variance with the previously presented data on metallurgical equipment, but there is a lag of from one to several years between the production of the equipment and the completion of installations. Thus the large production of metallurgical equipment in 1948, 1949, and 1950 probably reflects, in part, requirements for the first part of the Fifth Five Year Plan.
** Table 11 follows on p. 28.

Table 11

Estimated Planned and Actual Steel Production and Capacity a/ in the USSR at the End of the Fourth and Fifth Five Year Plans b/ 1950 and 1955

Thousand Tons

	Production				Capacity			
	Planned		Actual		Planned		Actual	
			At the End of				At the End of	
	1950	1955	1950	1955	1950	1955	1950	1955
Pig iron	19,500	34,000	19,300	33,000	22,350 c/	27,300 c/	20,650	34,400
Crude steel	25,400	43,900	27,100	43,700	29,050 c/	41,400 c/	29,150	45,200
Rolled steel	19,500 d/	32,000 d/	19,500 d/	32,000 d/	20,100 c/	41,900 c/	20,950	33,100

a. Exclusive of planned capacity added because of productivity gains.
b. Figures for 1950 planned output and capacity are based on source 50/. The 1955 actual production estimates are based on CIA data. Figures for 1955 planned production and capacity are based on percentage increases from the Fifth Five Year Plan. Both 1950 and 1955 actual capacity figures are, respectively, the mean of 1950 and 1951 production and the mean of 1955 and 1956 production.
c. Computed by adding announced planned capacity additions for the plan period to the estimated capacity at the beginning of the plan period; does not include planned increases due to productivity gains.
d. Includes steel castings and forgings.

of 1950, or (b) that potential productivity gains were more heavily relied on than in the Fourth Five Year Plan. The latter appears more likely.*

By 1953, owing to new units and improved productivity, production had been raised above the 1950 level by the following percentages:

* It is assumed throughout that capacity is utilized at all times as fully as possible.

Percent

Production of:	Due to New Capacity	Due to Improved Productivity
Pig iron	28	13
Crude steel	27	12
Rolled steel	26	16

By 1955, estimated production increases over 1950 will be as follows:

Percent

Production of:	Due to New Capacity	Due to Improved Productivity
Pig iron	54	17
Crude steel	44	17
Rolled steel	41	23

For 1955 the estimated planned production increases due to improved productivity are 44 percent for pig iron and 20 percent for steel.*

It follows, then, that increases in blast furnace and steel smelting equipment installations will be larger than planned for the Fifth Five Year Plan period. Productivity gains have been less than planned, making the situation the reverse of that in 1946-50.

Since 1950 the only information available concerning plan fulfillment for metallurgical equipment appeared in the announcements of plan fulfillment for 1953. The plan for production of some types of rolling mill equipment and shortage types of rolled steel was underfulfilled. The plan for production of steel smelting and blast furnace equipment was overfulfilled. Capital investment in the ferrous metals was greater than in 1952, but the plan for capital investment and for placing production capacities into operation was greatly underfulfilled. 51/

* The situation with respect to rolled steel is not clear. The planned increase in capacity was greater than the planned increase in production.

The requirements computations in Appendix C indicate that 11 to 23 new blast furnaces would be required for 1951-53. On 12 March 1954, M. Z. Saburov stated that 18 blast furnaces were brought into production from 1950 to 1953. 52/ There is no similar check on the steel furnace estimates.

In Table 10* an estimate was made of the capacities of all rolling mills known to be completed in Soviet plants during 1951, 1952, and 1953. The estimated total capacities of these mills and the estimated increases in production from new units are shown in Table 12.

Table 12

Known Capacity of Complete Units of Rolling Mills Produced during 1951-53 Compared with Required Capacity of Rolling Mills in the USSR 1952-54

Thousand Tons

Type of Mill	Capacities Produced 1951-53	Capacities Required of New Mills 1952-54 (or 1953-55) a/	Percent of Rolled Steel from New Mills
Blooming mill	5,700	4,830	39.3
Rail-structural mill	2,160	2,090	17.0
Tube mill	375	148	1.2
Cold strip mill	50	25	0.2
Hot strip mill	75	74	0.6
Sheet mill	650	517	4.2
Totals	9,010	7,684	62.5

a. Assuming either a 1-year or a 2-year lag between manufacture and installation of the equipment, the 3-year total requirements are about the same.

Deducting the blooming mill reportedly sent to Poland,** the two figures approximately balance for rolling mills. Although the above

* P. 26, above.
** See Table 10, p. 26, above.

data seem to indicate that the mills produced are adequate for the domestic requirements of the USSR, the estimates are at best crude, because capacities assigned to some mills, where the sizes of the mills were not given, are not necessarily accurate; the product mix assumed for rolled steel cannot be checked for accuracy; and the mills produced may or may not be of the sizes required to meet the needs for particular rolled products.

It appears that the USSR can produce about 60 to 65 percent of the units necessary for rolled steel production in the last half of the Fifth Five Year Plan. This estimate is valid only if the requirements for particular sizes and types within general categories of rolled products are met. Some mills, other than the one indicated for Poland, might have been produced for export. Presumably the USSR will meet internal needs first.

In the list of mills produced, the following types are not included: billet, rod, skelp, plate, bar, wheel, and welded pipe. Among the reparations ordered from East Germany during 1951 to 1955 are plate, pipe, and wire mills, or parts for them, as well as unspecified types of rolling mills. The scaling down of plans for East Germany may affect the Soviet supply situation adversely, but the extent cannot be determined at this time.

The USSR appears to be meeting its equipment requirements for blast furnaces and steel furnaces but not for all kinds of rolling mills. The rolling mill shortage will cause shortages of some kinds of vitally needed rolled steel unless new sources of supply are found. Difficulties in meeting requirements for rolling mill equipment appear to have persisted over a number of years.

E. External Sources of Supply.

Since the establishment of the embargo on strategic goods from the West to the Soviet Bloc, East Germany appears to be the only important supplier of ferrous metallurgical equipment to the USSR. Actual deliveries cannot be determined because of the scarcity of trade information and the difficulty in identifying specific items as steel plant equipment. Nearly all of the information available deals with planned reparations. Value data are generally stated in either rubles or Deutsche Mark East (DME) and suffer from two major deficiencies: (1) the sources rarely state whether the prices are those of the current

year, those of another base year, or statistical fixed planning prices, and (2) the Soviet prices for valuing reparations are lower than those used in East Germany. 53/

Planned reparations of steel plant equipment for 1950 were valued at 64 million DME, in 1944 prices. Included in this plan were more than 15,000 tons of rolling mill equipment, over 300 wire-drawing benches, and 26 cranes. 54/

From 1952 to 1955, annual planned deliveries to the USSR from East Germany reportedly included 30 million rubles of metallurgical equipment. In addition, 5,000 tons of blast furnace equipment and 1,000 tons of steel furnace equipment would be delivered each year. 55/ Reparations orders include wire-drawing equipment, plate mill parts, tube mills, cold-rolling mills, cranes, and many miscellaneous rolling mill parts. 56/ Of the items which can be identified as steel plant equipment to be delivered from 1953 to 1955, most are rolling mill parts and auxiliaries. The East German heavy machine production program for 1953 originally called for the manufacture of twenty-three 350-mm rolling mills. Of these, 16 were to be delivered to the USSR. The East German Planning Commission considered the program impossible to fulfill but had to yield to Soviet pressure. 57/

The USSR controls directly eight of the largest heavy machinery plants in East Germany. One of these is the Ernst Thaelman plant (formerly Krupp-Gruson) in Magdeburg, which was the only important prewar producer of metallurgical machinery in the present Soviet Zone. Others of these plants are capable of producing cranes and heavy machinery for the steel industry. The total productive capacity of these plants was valued at nearly 500 million DME in late 1953. About 40 million DME of metallurgical equipment was scheduled for production in 1953. About 60 percent of the total production of the 8 plants is sent to the USSR. 58/

It is not known what effect the New Course in East Germany will have on Soviet procurements. Soviet drains on the East German heavy machine-building output are apparently responsible for the drastic cutback in East German steel expansion plans, and some of the strain on the heavy machine-building industry may be relieved by cutbacks in deliveries of metallurgical equipment to the USSR.

In January 1954, the USSR received a large British trade delegation, and Soviet authorities indicated interest in importing equipment

from the UK. Among the items noted were concentrating, crushing, and grinding equipment valued at 15 million rubles; 50,000 tons of rolling mill equipment valued at 200 million rubles; and 20 plate-straightening and plate-bending machines. All three of these categories include steel plant equipment. Deliveries would be made from 1955 to 1957. 59/ These trade transactions, if completed, might obviate the investment of additional resources in heavy machine-building capacity.

IV. Conclusions.

A. Capabilities.

The USSR has the technical capability to produce all types of metallurgical equipment. There is considerable evidence, however, that because of technical and organizational problems and the burden imposed on the heavy machine-building facilities by expanding production of large capital goods, some types of rolling mill equipment cannot be produced in sufficient quantity for immediate needs.

Through improvement in the productivity of metallurgical equipment, the Soviet steel industry was able to meet the planned goals for steel production in 1950, despite the undersupply of equipment. Since 1950, new capacity for pig iron and crude steel has been larger than planned, and new capacity for rolled steel has been smaller than planned. The production of equipment for blast furnaces and steel furnaces was also more than planned in 1953, and plans for the production of some types of rolling mills were not fulfilled.

The Fifth Five Year Plan called for an 85-percent increase over 1950 production in the production of metallurgical equipment by 1955, but production in 1951, 1952, and 1953 was below the 1950 level. In order to reach the goal set for 1955, the production of metallurgical equipment must be nearly double that of 1953. This goal will not be met unless new machine-building capacity comes into production or resources are shifted from other kinds of heavy machinery.

B. Vulnerabilities.

The production of ferrous metallurgical equipment in the USSR is vulnerable both economically and geographically. Although the metallurgical equipment industry is somewhat dispersed, locations in the west, such as Kramatorsk, Dnepropetrovsk, Leningrad, Elektrostal', and Moscow,

still have concentrations of the industry's capacity. Actually, the plants producing metallurgical equipment are likely to be engaged in the production of military goods during a hot war. The production of metallurgical equipment would be limited to replacement of operating facilities or production of such new equipment as would be required to support the war program.

East Germany and Czechoslovakia are the only Soviet Bloc countries that appear capable of contributing to the alleviation of rolling mill shortages in the USSR. Any action which would stop or limit the export of rolling mill equipment from these countries or from countries outside the Soviet Bloc would hamper the development of the war potential of the USSR.

C. Intentions.

There is no reason to believe that the 1953 consumer goods program will lead to any substantial curtailment in the production of metallurgical equipment. Steel production through 1953 appeared to be moving toward the 1955 targets.

The production of metallurgical equipment in 1953 in the USSR showed an increase of 18 percent over 1952, whereas the increase in 1952 over 1951 was 12 percent. The original Fifth Five Year Plan implies an average annual rate of increase of about 13 percent. The acceleration in the rate of increase since 1951 may indicate an attempt to make up the losses in production suffered in that year. In any event, it seems likely that the production of metallurgical equipment will continue to grow at a fairly high rate.

APPENDIX A

GLOSSARY OF TERMS

This glossary of terms is included for the reader who has little knowledge of the equipment, processes, or terms used in metallurgy and steel plant operation. A complete list of terms would be too voluminous for inclusion in this report. Further technical details and descriptive material may be found in The Making, Shaping, and Treating of Steel, Sixth Edition, Pittsburgh, United States Steel Company, 1951; or The ABC of Iron and Steel, Sixth Edition, Cleveland, The Penton Publishing Company, 1950.

The terms listed below are those that are found most frequently in the body and appendixes of this report.

Agglomerating - A broad term used to include the beneficiation of coal, ore, coke, and limestone, whereby these materials are improved in physical form and properties and enriched for effective use in the blast furnaces. Agglomeration in effect raises the output of the furnace and lowers the cost of production of pig iron.

Bar - Hot-rolled, finished steel product having various cross-sectional forms, including small shapes.

Bessemer Converter - A special type of furnace used to make steel from cast iron by burning out carbon and other impurities through the use of a blast of air forced through the molten metal.

Billet - A bar of metal rolled from an ingot or bloom usually measuring 4 by 4 inches in cross section or less.

Blast Furnace - A furnace in which iron ore is reduced to liquid pig iron.

Bloom - A bar of metal rolled from an ingot usually measuring 4 by 4 inches in cross section or larger.

Cold-Rolling - A process to improve the surface and mechanical properties of a product.

Electric Furnace - A furnace used usually for the production of special alloy and high-grade steel.

Fines - Ore and coke particles, usually 0.75 inches or less in size.

Gangue - The non-iron-bearing portion of ore consisting mostly of silica, alumina, and moisture.

Ingot - A solidified steel casting.

Martin Furnace or Open Hearth Furnace - A furnace used for the refining of pig iron and scrap into steel.

Pig Iron - The direct metallic product, either solid or molten, of a blast furnace smelting iron ore.

Pipe - As defined in this report, pipe formed from skelp and having a butt, lap, or electric-welded seam.

Skelp - A hot-rolled strip, with square or slightly bevelled edges, which is formed into a butt-weld tube.

Slab - Any piece of steel to be rolled into a plate.

Slag - The fused product formed by the action of the flux upon the gangue of an ore or fuel or upon the oxidized impurities in a metal. Slag is sometimes referred to as cinder.

Steel - As defined in this report, the product of Martin furnaces, Bessemer converters, and electric furnaces.

Strip - A thin, flat product, rolled on a mill to the proper width and end-sheared only.

Structurals - Standard rolled steel pieces such as I-beams, channels, angles, wide flange beams, zees, tees, and others.

Tubes - As defined in this report, seamless tubes from pierced tube rounds.

Wire - Metal in the form of a thread, produced by drawing a rod through a steel die.

APPENDIX B

MACHINE-BUILDING PLANTS IN THE USSR
REPORTED TO BE PRODUCING FERROUS METALLURGICAL EQUIPMENT

1. Major Producing Plants, 1948-53.

City and Region	Plant Name	Plant Coordinates	Comments
Sverdlovsk (VIII)	Uralskiy Heavy Machine Building Plant imeni Ordzhonikidze (UZTM or Uralmash*)	56°52'45"N-60°35'20"E	Ranks first in the USSR in the production of metallurgical equipment.
Kramatorsk (III)	Novo-Kramatorsk Heavy Machine Building Plant imeni Stalin (NKMZ)	48°45'N-37°34'E	Ranks second in the production of metallurgical equipment.
Kramatorsk (III)	Staro-Kramatorsk Heavy Machine Building Plant imeni Ordzhonikidze (SKMZ)	48°43'30"N-37°33'E	Ranks third in the production of metallurgical equipment.
Orsk (VIII)	Yuzhno-Uralskiy Heavy Machine Building Plant (YuZTM)	51°14'15"N-58°30'30"E	Ranks fourth in the production of all types of metallurgical equipment.
Elektrostal' (VII)	Novo-Kramatorsk Heavy Machine Building Plant imeni Stalin (NKMZ)	55°47'N-38°28'E	Ranks fifth in the production of metallurgical equipment.
Irkutsk (XI)	Irkutsk Heavy Machine Building Plant imeni Kuybyshev (IZTM)	52°17'25"N-104°18'E	An important plant in the metallurgical equipment industry, producing complete units of all types.
Alma-Ata (Xa)	Alma-Ata Heavy Machine Building Plant (AZTM)	43°15'30"N-76°53'40"E	Ranks seventh in the production of equipment for rolling mills, blast furnaces, coke plants, and the like.
Leningrad (Ia)	Krasnyy Metallist Machine Building Plant	59°56'40"N-30°15'30"E	The principal supplier of lubricating systems for rolling mills. 60/

*- The abbreviation in parentheses is the commonly accepted abbreviated designation for the plant.

1. Major Producing Plants, 1948-53 (Continued).

City and Region	Plant Name	Plant Coordinates	Comments
Dnepropetrovsk (III)	Dnepropetrovsk Plant of Metallurgical Equipment (DZMO)	48°28'20"N-34°57'30"E	Considered one of the important manufacturers of metallurgical equipment.
Dnepropetrovsk (III)	Metal Construction Plant imeni Molotov	48°29'N-34°59'E	One of the most important steel fabricating plants in the USSR.
Leningrad (Ia)	Nevski Machine Building Plant imeni Lenin	59°53'08"N-30°24'40"E	Most important products of this plant are blowers for blast furnaces and Bessemer converters and exhausters for coke plants.

2. Minor Producing Plants, 1948-53.

Leningrad (Ia)	Automatic Lathe Factory	59°53'N-30°24'E	Produces wire-drawing machines. 61/
Debal'tsevo (III)	Debal'tsevo Machine Building Plant	48°21'N-38°25'E	Produces carriage mounted steel ladles, ingot molds, and the like. 62/
Dnepropetrovsk (III)	Metallurgical Plant imeni Komintern	48°30'N-35°02'E	Supplies rolls for rolling mills. 63/
Khar'kov (III)	Serp i Molot Agricultural Equipment	49°58'50"N-36°17'10"E	Produced rod-straightening benches during the period that prisoners of war were working there. 64/
Kramatorsk (III)	Steel Plant imeni Kuybyshev	48°44'N-37°33'E	Produces furnace equipment. 65/
Lutugino (III)	Descriptive name: Cast Iron Plant	48°24'N-39°12'E	One of the principal suppliers of rolling mill rolls. 66/
Odessa (III)	January Uprising Heavy Machine Building Plant	46°27'10"N-30°42'45"E	67/
Slavyansk (III)	Krasnyy Metallist Machine Plant		Belongs to State All Union Trust for the construction of coke ovens and chemical plants. 68/

2. Minor Producing Plants, 1948-53 (Continued).

City and Region	Plant Name	Plant Coordinates	Comments
Millerovo (IV)	Gabrilov Machine Building Plant	48°55'N-40°26'E	69/
Novocherkassk (IV)	Stankostroitel Machine Tool Factory	47°24'25"N-40°07'12"E	Produces wire-drawing machines. 70/
Rustavi (V)	Zakmetalstroi Building Material Factory	41°33'N-45°02'E	Has produced wire-drawing machines for the production of armature wire and blast furnace parts. 71/
Saratov (VI)	Electric Furnace Factory	51°31'30"N-46°00'10"E	Produces electric smelting furnaces. 72/
Bezhitsa (VII)	Krasnyy Profintern Locomotive Plant	53°18'15"N-34°19'30"E	Produces coke quenching cars. 73/
Gor'kiy (VII)	Krasnoye Gormova Plant imeni Zhdanov	56°21'20"N-43°52'30"E	74/
Kursk (VII)	Machine Building Factory imeni Kalinin	51°44'N-36°11'E	Produces machines for the production of roofing sheets. 75/
Moscow (VII)	Descriptive Name: Hoisting and Transport Equipment Plant	55°44'18"N-37°42'44"E	76/
Lys'va (VIII)	Lys'va Metallurgical Plant	58°06'20"N-57°47'20"E	Produces roller tables for rolling mills. 77/
Krasnodar (IV)	Machine Tool Factory imeni Sedin	45°00'15"N-58°00'15"E	Produces spare parts for the metallurgical industry. 78/

3. Past Producing Plants, Before 1948.

Kolpina (Ia)	Izhorski Steel Plant	59°45'30"N-30°35'E	One of the oldest heavy equipment plants in the USSR. Manufactures rolls for cold-rolling mills. 79/
Leningrad (Ia)	Elektrosila Electric Equipment Factory	59°53'N-30°20'E	Supplied many of the steel plants in the USSR with electric motors. 80/

3. Past Producing Plants, Before 1948 (Continued).

City and Region	Plant Name	Plant Coordinates	Comments
Leningrad (Ia)	Elektrik Electric Equipment Factory	59°58'30"N-30°19'02"E	Has produced small high-frequency melting-tempering furnaces. 81/
Leningrad (Ia)	Radio Factory	59°58'28"N-30°18'41"E	Has produced high-frequency melting furnaces. 82/
Dnepropetrovsk (III)	Machine Building Plant imeni Artem	48°28'30"N-35°05'10"E	Has produced equipment for coke ovens. 83/
Kiev (III)	Glavmashmet Machine Building Plant	50°28'N-30°30'E	Has produced equipment for coke ovens and reducers for blast furnaces. 84/
Makeyevka (III)	Remstroi Industrial Equipment Plant	48°03'N-30°E	Has manufactured parts for blast furnaces. 85/
Armavir (IV)	Armalit Machine Building Factory	45°00'15"N-41°06'20"E	86/
Baku (V)	Oil Equipment Factory, imeni Montin	40°22'30"N-49°52'55"E	Contributed to the construction of the tube-rolling mill in Azerbaydzhan. 87/
Zaporozh'ye (III)	Zaparozhstal Steel Plant	47°40'N-35°10'E	Has produced many items of metallurgical equipment for internal plant use. 88/
Gor'kiy (VII)	Krasnaya Aetna Steel Plant	56°17'45"N-43°54'15"E	Has produced wire-drawing benches. 89/
Moscow (VII)	Transformer Factory imeni Kuybyshev	55°47'20"N-37°42'15"E	Has produced electric furnaces. 90/
Moscow (VII)	Elektrozavod Electric Equipment Factory	55°45'N-37°48'E	Has produced furnaces for the melting of high-quality steel. 91/
Moscow (VII)	Elektrothermik Equipment Plant	55°45'N-37°48'E	Has produced electric arc furnaces of 0.5- to 1.5-ton capacity. 92/

3. Past Producing Plants, Before 1948 (Continued).

City and Region	Plant Name	Plant Coordinates	Comments
Moscow (VII)	Petroviskiy Machine Building Factory	55°45'N-37°48'E	In 1946, produced reducing gears for rolling mills. 93/
Chelyabinsk (VIII)	Chelyabinsk Metal Construction Plant imeni Ordzhonikidze	55°08'N-61°27'E (approximately)	In 1946, completed metal construction for blast furnace and for the reconstruction of a large rolling mill. 94/
Chusovoy (VIII)	Chusovoy Metallurgical Works	58°18'N-57°48'E	In 1947, was casting iron and steel couplings for rolling mills. 95/
Molotov (VIII)	Artillery Plant 172 imeni Molotov	58°01'45"N-56°16'40"E	Has produced complete equipment for rolling mills, open hearth furnaces, and blast furnaces. 96/
Ust'-Katav (VIII)	Oktyabr Railroad Car Factory	54°56'N-58°10'E	According to one source, was gearing to produce rolling mills in 1945. 97/
Verkhne-Neyvinskiy (VIII)	Verkhne-Neyvinskiy Plant		Was producer of cast rolls for rolling mills. 98/
Verkhniy Ufaley (VIII)	Coke Plant Equipment Factory		Was producing coke plant equipment for Magnitogorsk Metallurgical Combine in 1944. 99/
Krasnoyarsk (XI)	Armament Plant imeni Voroshilov	56°00'55"N-92°59'E	According to one source, has produced installations for blast furnace plants, steel plants, and rolling mills. 100/
Komsomol'sk (XII)	Order of Lenin Tractor Plant No. 313	50°36'30"N-137°00'40"E	According to a source of 1945, produced electric melting furnaces during the war. 101/
Magadan (XII)	Marchekan Shipyard Repair Plant	59°32'05"E-150°46'15"E	In 1946, built and put into operation an electric melting furnace for the production of alloy steel for Dal'stroy undertaking. 102/
Sinegorsk (XII)	Central Ironworks	47°10'N-142°31'E	According to one source of 1948, produced rolling mill rolls. 103/

APPENDIX C

METHODOLOGY

1. Estimates of Nonelectrical Equipment Requirements.

The methodology of estimating the nonelectrical equipment requirements of the Soviet iron and steel industry is given in detail in Sections 2 through 8 and Section 10 of this appendix.

The term equipment requirements, as used in this report, refers to the nonelectrical equipment which the iron and steel industry must have installed and in operation in a given year in order to increase the iron and steel production by a given quantity over the preceding year's production and to maintain the stock of equipment necessary for the production of the current year.

Requirements estimates were based on estimates of actual iron and steel production for 1953 and previous years. For 1954 and later years, the iron and steel production estimates are based on plan announcements and CIA judgment as to the probable extent of plan fulfillment.

The estimates of replacement requirements were based on the estimated capacity of the industry in the year preceding that for which the estimate was made, except for capital repairs of blast furnaces. The method used for these estimates is explained in Section 2.

2. Estimates of Blast Furnace Equipment Requirements, 1951-60.

Estimates of equipment requirements for blast furnaces in the USSR have been based on CIA estimates of pig iron production* and Soviet data on the production of pig iron relative to blast furnace volume. Relationships between production and blast furnace capacity were determined by the application of the Soviet coefficients of utilization, which are available for the entire industry and are defined by the following formula:

* See Table 9, p. 24, above.

$$C = \frac{VD}{T}, \text{ where}$$

C = the coefficient of utilization of blast furnace volume;
V = the useful volume of blast furnaces, measured in cubic meters;
D = the average number of days of operation of blast furnaces (assumed to be 340); and
T = the annual production of pig iron for the entire industry, measured in tons.

Coefficients for 1954 and later years were assumed on the basis of the trend for 1950-53 and are shown in Table 13.* The postwar reconstruction and expansion program was accompanied by a modernization process which greatly improved blast furnace productivity. Continued improvement can be expected, but at a declining rate. The coefficients are therefore assumed to fall a constant amount (0.01) each year from 1953 to 1960.

Also given in Table 13 are estimates of equipment requirements for new blast furnaces during the period 1951 to 1960. Calculation of these estimates involved the following procedures:

a. The blast furnace volume in each year was determined by use of the coefficient of utilization formula, transposed thus: $V = \frac{TC}{D}$

b. Increments to blast furnace volume were determined from the estimates of total volume.

c. The total weight of nonelectrical equipment was determined by aggregation of the weights of components for each of the three standard sizes of Soviet blast furnaces. 104/ The weights, in tons, of equipment for each size furnace are as follows:

1,300 cubic meters	3,650 tons
1,000 cubic meters	3,000 tons
600 cubic meters	2,230 tons

d. The average weight per cubic meter of furnace volume was multiplied by the increment to furnace volume for each year. The weight per cubic meter of the 1,000-cubic-meter furnace (3-ton) was taken as representative of the newly constructed units.

* Table 13 follows on p. 45.

Table 13

Estimated Nonelectrical Equipment Requirements for New Blast Furnace Capacity in the USSR for 1951-60

Year	Pig Iron Production (Million Tons) a/	Coefficient of Utilization	Blast Furnace Volume Required (Thousand Cubic Meters)	Increment to Blast Furnace Volume (Thousand Tons)	Equipment Requirements (Thousand Tons)
1950	19.3	0.98 105/	55.6	Negligible	Negligible
1951	22.0	0.92 106/	59.5	3.9	11.7
1952	25.1	0.88 107/	65.0	5.5	16.5
1953	27.4	0.86 108/	69.5	4.5	13.5
1954	30.2	0.85	75.5	6.0	18.0
1955	33.0	0.84	81.5	6.0	18.0
1956	35.8	0.83	87.4	5.9	17.7
1957	38.6	0.82	93.1	5.7	17.1
1958	42.4	0.81	101.0	7.9	23.7
1959	46.2	0.80	108.7	7.7	23.1
1960	50.0	0.79	116.2	7.5	22.5

a. From Table 9, p. 24, above.

Blast furnace replacement requirements result from two kinds of repair: capital and current. The average time between capital repairs for Soviet blast furnaces is 3.25 years. A capital repair requires the replacement of approximately one-third of the nonelectrical equipment of the furnace. The equipment requirements for capital repairs in any year (R_c) can be computed by the formula $R_c = \frac{3.72}{(3.25)(3)} V_{-3} = .382 V_{-3}$, where V_{-3} = the total useful furnace volume of the industry 3 years previously and the average weight of equipment per cubic meter of furnace volume is 3.72* tons.

* The figure is based on the 600-cubic-meter furnace, since the estimated average size of existing furnaces ranges from 530 cubic meters in 1950 to 730 cubic meters in 1960. For new construction, the average size is assumed to be 1,000 cubic meters.

Current repairs require the replacement of approximately 5 percent, by weight, of the blast furnace equipment operating in any year. Requirements for current repairs (R_s) can be computed by the following formula: $R_s = (3.72)\ (.05)\ V_{-1} = .186$ where V_{-1} = the total useful furnace volume in the preceding year.

The total equipment requirements for replacement (R) would then be equal to $R_c + R_s$, or .568 V. These requirements are shown for 1951-60 in Table 14.*

3. Estimates of Crushing and Agglomerating Equipment Requirements.

The Fourth Five Year Plan called for the production of 15.1 million tons of agglomerate in 1950, raising the share of agglomerate to 38 percent and taking care of the ore fines and blast furnace dusts. The agglomeration of ores is required because of the increasing necessity in the USSR to use leaner and leaner ores and to make blast furnace production more economical.

For estimating purposes, then, it will be assumed that the ore distribution is such that 40 percent of the blast furnaces require this equipment and that the remainder are using ores that require no processing.

Data from Soviet sources 109/ indicate that the ton weights of crushing and agglomerating equipment per cubic meter of furnace volume for the 3 standard Soviet blast furnaces are 1.05 for the 600-cubic-meter size, 1.24 for the 1,000-cubic-meter size, and 1.08 for the 1,300-cubic-meter size. For estimating the crushing and agglomerating equipment required for new blast furnaces, it was assumed that 1.15 tons of such equipment would be required per cubic meter of furnace volume for 40 percent of the new furnaces. The estimating formula is thus $CA_n = (1.15)\ (.4dV) = .46dV$, where CA_n = crushing and agglomerating equipment requirements (in tons) for new furnaces; and dV = the increment to blast furnace volume (in cubic meters) since the preceding year.

Approximately 5 percent (by weight) of the existing crushing and agglomerating equipment must be replaced each year. Assuming that the weight of existing crushing and agglomerating equipment is 1.15 tons for each cubic meter of furnace volume for 40 percent of the furnace

* Table 14 follows on p. 47.

Table 14

Estimated Nonelectrical Equipment Replacement Requirements for Blast Furnaces in the USSR for 1951-60

Year	Blast Furnace Volume (Thousand Cubic Meters)	Equipment Requirements for Capital Repairs (Thousand Tons)	Equipment Requirements for Current Repairs (Thousand Tons)	Total Nonelectrical Replacement Equipment Requirements (Thousand Tons)
1948	43.2	a/	a/	a/
1949	49.2	a/	a/	a/
1950	55.6	a/	a/	a/
1951	59.5	16.5	10.3	26.8
1952	65.0	18.8	11.1	29.9
1953	69.5	21.2	12.1	33.3
1954	75.5	22.7	12.9	35.6
1955	81.5	24.8	14.0	38.8
1956	87.4	26.5	15.2	41.7
1957	93.1	28.8	16.3	45.1
1958	101.0	31.1	17.3	48.4
1959	108.7	33.4	18.8	52.2
1960	116.2	35.6	20.2	55.8

a. Not applicable.

volume, the replacement requirements for crushing and agglomerating equipment (CA_R), in tons, can be estimated by the following formula: $CA_R = (1.15)(.4V)(.05) = .023V$, where V = the total volume of blast furnaces (cubic meters) in the preceding year.

Crushing and agglomerating equipment requirements are shown in Table 15.*

* Table 15 follows on p. 48.

Table 15

Estimated Nonelectrical Equipment Requirements
for Crushing and Agglomerating Equipment in the USSR
for 1951-60

Thousand Tons

Year	V [a]	dV [a]	New Units	Replacement	Total
1950	55.6	[b]	[b]	[b]	[b]
1951	59.5	3.9	1.8	1.3	3.1
1952	65.0	5.5	2.5	1.4	3.9
1953	69.5	4.5	2.1	1.5	3.6
1954	75.5	6.0	2.8	1.6	4.4
1955	81.5	6.0	2.8	1.7	4.5
1956	87.4	5.9	2.7	1.9	4.6
1957	93.1	5.7	2.6	2.0	4.6
1958	101.0	7.9	3.6	2.1	5.7
1959	108.7	7.7	3.5	2.3	5.8
1960	116.2	7.5	3.5	2.5	6.0

a. From Table 13, p. 45, above.
b. Not applicable.

4. Estimates of Coke Oven Equipment Requirements.

Estimates of coke oven equipment requirements were based on the Gipromez standard 65-oven battery having a normal charging capacity of 15 tons of prepared coal. According to Soviet data 110/, the weight of the nonelectrical equipment of the entire battery is approximately 1,385 tons, including coal yard and coal preparation equipment. Yield and production assumptions, based on US experience, 111/ are as follows:

a. The coke charged into blast furnaces amounts to 89.3 percent, by weight, of the gross coke produced for ferrous metallurgy.

b. Each ton of pig iron produced requires 0.95 ton of coke to be charged into the blast furnace.

c. Therefore, the gross production of coke required, relative to the production of pig iron, is 0.950/0.893, or 1.06.

d. The standard 65-oven coke battery will produce approximately 415,700 tons of coke annually.

From the above data, the equipment requirements were computed. They are shown below, in Table 16. It is assumed that only complete 65-oven batteries will be placed in operation and that any portion of a new battery's capacity which is not required in the year of its installation will be used to meet part of the requirements of the following year.

Table 16

Estimated Nonelectrical Equipment Requirements
for New Coke Oven Batteries in the USSR
for 1951-60

Year	Pig Iron Production (Million Tons)	Gross Coke Production Required (Million Tons)	Increment to Gross Coke Production (Million Tons)	Number of Complete New 65-Oven Batteries Required	Equipment Requirements (Thousand Tons)
1950	19.3	20.5	a/	a/	a/
1951	22.0	23.3	2.8	7	9.7
1952	25.1	26.6	3.3	8	11.1
1953	27.4	29.0	2.4	6	8.3
1954	30.2	32.0	3.0	7	9.7
1955	33.0	35.0	3.0	7	9.7
1956	35.8	37.9	2.9	7	9.7
1957	38.6	40.9	3.0	8	11.1
1958	42.4	44.9	4.0	9	12.5
1959	46.2	49.0	4.1	10	13.9
1960	50.0	53.0	4.0	10	13.9

a. Not applicable.

Approximately 5 percent (by weight) of the equipment of coke ovens must be replaced each year. On the basis of the relationships given

above, the coke oven replacement equipment requirements can be computed by the following formula: $C_R = \frac{(1,385)\ (.05)}{415,700}\ P = .00017$, where C_R = the coke oven equipment requirements (in tons) for replacement in a given year and P = the gross coke production required in the previous year. Replacement requirements are given in Table 17.

Table 17

Estimated Nonelectrical Equipment Replacement Requirements for Coke Oven Batteries in the USSR for 1951-60

Tons

Year	Gross Coke Production Required (Million)	Equipment Replacement Requirements (Thousand)
1950	20.5	Not applicable
1951	23.3	3.5
1952	26.6	4.0
1953	29.0	4.5
1954	32.0	4.9
1955	35.0	5.4
1956	37.9	6.0
1957	40.9	6.4
1958	44.9	7.0
1959	49.0	7.6
1960	53.0	8.3

5. Estimates of Martin (Open Hearth) Equipment Requirements.

Estimates of Martin furnace equipment requirements were based on CIA estimates* of steel production and Soviet data on the productivity of equipment. The following procedures were used:

a. The production of Martin steel was estimated on the assumption that 90 percent of the steel production was from Martin furnaces.

* See Table 9, p. 24, above.

b. The total Martin furnace hearth area required in any year was computed. The production per square meter of hearth area for 1950 through 1953 was taken from official Soviet statements. The trend in the coefficients was then projected through 1960. The formula for the Martin furnace coefficients is $C = \frac{T}{AD}$, where T = the annual production of Martin steel in tons; A = the hearth area in square meters; C = the average daily production per square meter of hearth; and D = the average number of days of operation per furnace in the year (here assumed to be 325).

c. The increment in hearth area from year to year was computed.

d. From Soviet data, 112/ it was determined that the equipment requirements per square meter of hearth for the 3 standard Soviet Martin furnaces (70-ton, 150-ton, and 350-ton) range between 19.4 and 27.3 tons. For estimating purposes it was assumed that 23.4 tons of equipment would be required for each square meter of hearth.

e. The increment to hearth area in each year was multiplied by 23.4 to obtain estimates of the equipment requirements for new Martin furnaces. The resulting figures are shown in Table 18.*

Replacement equipment for Martin furnaces is required for both capital and current repairs. The following assumptions were made for purposes of estimating these requirements:

a. The average Martin furnace undergoes a capital repair about every 18 months. Consequently, in each year about 66 percent of the furnaces which have been in operation a minimum of 18 months will require capital repairs.

b. Each capital repair requires the replacement of about 15 percent (by weight) of the equipment of a Martin furnace.

c. Each Martin furnace undergoes current repairs on an average of every 9 months.

d. Each current repair requires the replacement of about 2 percent (by weight) of the equipment of a Martin furnace.

* Table 18 follows on p. 52.

Table 18

Estimated Nonelectrical Equipment Requirements
for New Martin Furnaces in the USSR
for 1951-60

Year	Steel Production (Million Tons)	Production of Martin Steel a/ (Million Tons)	Daily Production of Martin Steel per Square Meter of Hearth (Tons)	Martin Furnace Hearth Area Required (Thousand Square Meters)	Increment to Martin Furnace Hearth Area (Square Meters)	Equipment Requirements (Thousand Tons)
1950	27.1	24.4	5.70 b/	13.2	Not applicable	Not applicable
1951	31.2	28.1	5.90 c/	14.6	1.4	32.8
1952	34.3	30.9	6.19 d/	15.4	0.8	18.7
1953	37.7	33.9	6.50 e/	16.1	0.7	16.4
1954	40.7	36.6	6.70	16.8	0.7	16.4
1955	43.7	39.3	6.80	17.8	1.0	23.4
1956	46.7	42.0	6.88	18.8	1.0	23.4
1957	49.7	44.7	6.95	19.8	1.0	23.4
1958	53.1	47.8	7.02	21.0	1.2	28.1
1959	56.5	50.9	7.09	22.1	1.1	25.7
1960	60.0	54.0	7.16	23.2	1.1	25.7

a. Computed at 90 percent of steel production.
b. 113/
c. 114/
d. 115/
e. 116/

e. The average size of Martin furnaces in the USSR during 1951-60 is estimated to range between 30 and 40 square meters (hearth area). For an estimate of replacement requirements, the 70-ton furnace weight was used, since that size closely approximates the average. The estimated weight of equipment per square meter of hearth for the 70-ton furnace ranges between 21.9 and 27.3 tons. For the computations, 24.6 tons was assumed.

From these factors, the equipment replacement estimating equation, $R = \frac{(2A)(24.6)}{(3)(7)} + \frac{(4A)(24.6)}{(3)(50)} = 3.00\ A$, was derived (R = the total replacement requirements for Martin furnace equipment in a given year and A = the installed Martin furnace hearth area [in square meters] in the preceding year). The replacement requirements are shown in Table 19.

Table 19

Estimated Nonelectrical Equipment Replacement Requirements for Martin Furnaces in the USSR for 1951-60

Year	Martin Furnace Hearth Area (Thousand Square Meters)	Equipment Replacement Requirements (Thousand Tons)
1950	13.2	Not applicable
1951	14.6	39.6
1952	15.4	43.8
1953	16.1	46.2
1954	16.8	48.3
1955	17.8	50.4
1956	18.8	53.4
1957	19.8	56.4
1958	21.0	59.4
1959	22.1	63.0
1960	23.2	66.3

6. Estimates of Equipment Requirements for Steelmaking Furnaces, Excluding Martin Furnaces.

Of the total Soviet steel production, 3.5 percent was assumed to be Bessemer steel and 6.5 percent, electric steel. Further assumptions used in the requirements estimates are listed below:

a. Equipment requirements for Bessemer steel were estimated in terms of 15-ton units, the annual production of each unit being about 120,000 tons.

b. Bessemer converters were assumed to have sources of hot pig iron from adjacent Martin furnace installations.

c. The equipment of each 15-ton converter weighs approximately 330 tons. 117/

d. Equipment requirements for electric steel were computed in terms of 30-ton electric furnaces with an annual production of about 30,000 tons per furnace.

e. Stripping facilities and the like were assumed to be available.

f. The equipment of each 30-ton electric furnace weighs approximately 190 tons.

From these factors, the equipment requirements for new capacity were computed, as shown in Table 20.*

Approximately 10 percent (by weight) of the equipment of a Bessemer converter must be replaced each year. On the basis of the 15-ton converters discussed above, the equipment-output ratio of 330/120,000, or 0.0028, was used to estimate the stock of converter equipment in the USSR in 1950. The estimated tonnage of new equipment for each year was added to the 1950 stock estimate to determine the changes in the stock. Replacement requirements were estimated for each year to be 10 percent (by weight) of the preceding year's stock.

A similar procedure was followed in estimating replacement requirements for electric furnaces. The equipment-output ratio for electric furnaces is 190/30,000, or 0.0063. A replacement rate of 10 percent was also assumed for electric furnaces. The resulting replacement requirements are given in Table 21.**

The estimates of equipment requirements for Martin furnaces, Bessemer converters, and electric furnaces, shown above in Tables 18 through 21, were aggregated to determine the equipment requirements for all steel furnaces. The aggregates are given in Table 22.***

* Table 20 follows on p. 55.
** Table 21 follows on p. 56.
*** Table 22 follows on p. 57.

Table 20

Estimated Nonelectrical Equipment Requirements
for New Bessemer Converters and Electric Furnaces in the USSR
for 1951-60

Year	Production of Bessemer and Electric Steel (at 10 Percent of Total) (Million Tons)	Increment to Bessemer and Electric Steel Production (Million Tons)	Approximate New 15-Ton Equivalent Bessemer Converters Required	Approximate New 30-Ton Equivalent Electric Furnaces Required	Equipment Requirements for New Bessemer Converters and Electric Furnaces (Thousand Tons)
1950	2.71	a/	a/	a/	a/
1951	3.12	0.41	2	9	2.4
1952	3.43	0.31	1	7	1.7
1953	3.77	0.34	1	7	1.7
1954	4.07	0.30	0	7	1.3
1955	4.37	0.30	1	6	1.5
1956	4.67	0.30	1	7	1.7
1957	4.97	0.30	1	6	1.5
1958	5.31	0.34	1	9	1.8
1959	5.65	0.34	1	8	1.5
1960	6.00	0.35	1	6	1.8

a. Not applicable.

7. Estimates of Ferrous Rolling Mill Equipment Requirements, 1951-60.

Estimates of rolling mill equipment requirements were based on estimates of the distribution of rolled steel production, by type, and on equipment-output ratios derived from Soviet and US data. The following procedures were used in deriving the estimates:

a. Cast steel, forged steel, and some semifinished (primary and intermediate) steel, which are included in the Soviet rolled steel category, were deducted from the rolled steel production estimate for

Table 21

Estimated Nonelectrical Equipment Replacement Requirements for Bessemer Converters and Electric Furnaces in the USSR for 1951-60

Thousand Tons

	Bessemer Converters		Electric Furnaces		
Year	Stock	Replacement Requirements	Stock	Replacement Requirements	Total Replacement Requirements
1950	2.66	a/	11.09	a/	a/
1951	3.32	0.27	12.80	1.11	1.38
1952	3.65	0.33	14.13	1.28	1.61
1953	3.98	0.37	15.46	1.41	1.78
1954	3.98	0.40	16.79	1.55	1.95
1955	4.31	0.40	17.93	1.68	2.08
1956	4.64	0.43	19.26	1.79	2.22
1957	4.97	0.46	20.40	1.93	2.39
1958	5.30	0.50	21.92	2.04	2.54
1959	5.63	0.53	23.25	2.19	2.72
1960	5.96	0.56	24.27	2.33	2.89

a. Not applicable.

1951 given in Table 23.* The ratio of the remainder (finished hot-rolled steel) to the total rolled steel was determined to be 0.938. That relationship was also assumed to apply to 1950 and 1952-60.

b. The requirements of primary and intermediate rolled steel for 1951 were computed on the basis of the estimated distribution by type of finished hot-rolled steel in 1951 and US data giving yields from various primary and intermediate rolled products to the finished hot-rolled products.

c. The equipment-output ratio for each type of rolled steel was determined. 118/ The estimated 1951 production of each type was multiplied by the appropriate coefficient to obtain an estimate of the

* Table 23 follows on p. 58, below.

Table 22

Estimated Nonelectrical Equipment Requirements for All Steel Furnaces in the USSR a/ for 1951-60

Thousand Tons

Year	Equipment for New Units	Replacements	Total
1951	35.2	41.0	76.2
1952	20.4	45.4	65.8
1953	18.1	48.0	66.1
1954	17.7	50.3	68.0
1955	24.9	52.5	77.4
1956	25.1	55.6	80.7
1957	24.9	58.8	83.7
1958	29.9	61.9	91.8
1959	27.2	65.7	92.9
1960	27.5	69.2	96.7

a. Based on Tables 18, 19, 20, and 21, pp. 52, 53, 55, and 56, respectively, above.

stock of equipment required for that production.* The tonnages of the 1951 production of various kinds of hot- and cold-rolled steel were aggregated. The equipment requirements (in tons) were totaled and divided by the total production. The over-all equipment-output ratio thus derived for hot- and cold-rolled steel was 0.0191.

d. The estimates of rolled-steel production** for 1950 and 1952-60 were multiplied by 0.938 to obtain finished hot-rolled steel estimates for those years. The finished hot-rolled steel estimates were then multiplied by 2.93*** to obtain estimates of the total hot- and cold-rolled steel production. These estimates are given in Table 24.****

* See Table 23, p. 58, below.
** See Table 2, p.10, above.
*** The ratio of hot- and cold-rolled steel (primary, intermediate, and finished hot-rolled steel, cold-rolled strip and sheets, and tinplate) to finished hot-rolled steel is 2.93 (see Table 23).
**** Table 24 follows on p. 60.

Table 23

Estimated Production of Hot- and Cold-Rolled Steel and Stock of Nonelectrical Rolling Mill Equipment in the USSR 1951

Product	Production a/ (Million Tons)	Estimated Ratio of Nonelectrical Equipment Required to Annual Production b/	Estimated Stock of Nonelectrical Equipment Required (Thousand Tons)
Primary and intermediate hot-rolled steel			
Blooms and slabs	24.20	0.0091	225.0
Billets	9.78	0.0034	33.3
Tube-rounds	0.82	0.0126	10.3
Wire rods	1.32	0.0096	12.7
Skelp	0.54	0.0055	3.0
Other intermediate	2.18	0.0392	85.5
Total	38.84	0.0095	369.8
Finished hot-rolled steel			
Light structurals	6.33	0.0256	162.0
Sheared plate	2.69	0.0381	102.5
Sheet	2.58	0.0471	121.5
Rails and accessories	2.93	0.0366	107.2
Bars	1.57	0.0392	61.5
Wire	1.26	0.0418	52.7
Heavy structurals	1.19	0.0444	52.8
Seamless tube	0.73	0.0408	29.8
Wheels and tires	0.52	0.0570	29.6
Welded pipe	0.49	0.0140	6.9
Strip	0.39	0.0365	14.2
Universal plate	0.34	0.0253	8.6
Total	21.02	0.0356	749.3

Table 23

Estimated Production of Hot- and Cold-Rolled Steel and Stock of Nonelectrical Rolling Mill Equipment in the USSR
1951
(Continued)

Product	Production a/ (Million Tons)	Estimated Ratio of Nonelectrical Equipment Required to Annual Production b/	Estimated Stock of Nonelectrical Equipment Required (Thousand Tons)
Cold-rolled steel			
Cold-rolled sheet	1.29	0.0356	45.9
Cold-rolled strip	0.15	0.0356	5.3
Tinplate	0.23	0.0300	6.9
Total	1.67	0.0348	58.1
Grand total	61.53	0.0191	1,177.2

a. Based on CIA estimates of the distribution of rolled steel production in 1951, by type.
b. Derived from information in 119/.

e. Unfortunately, there are no published productivity coefficients for rolling mills similar to the coefficients of utilization for blast furnaces and Martin furnaces. It is assumed that the productivity of rolling mills will increase during 1951-60 by about the same percentages as the furnaces. The percentage increases (over the preceding year) per unit for all rolling mills are assumed to be as follows:

1951 and 1952	5
1953	4
1954	3
1955	2
1956 through 1960	1

Table 24

Estimated Finished Hot-Rolled
and Total Hot- and Cold-Rolled Steel Production
in the USSR
1950-60

Million Tons

Year	Rolled Steel Production (Soviet Definition) a/	Estimated Finished Hot-Rolled Steel Production b/	Estimated Total Hot- and Cold-Rolled Steel Production c/
1950	19.5	18.3	53.6
1951	22.4	21.0	61.5
1952	25.1	23.5	68.9
1953	27.6	25.9	75.9
1954	29.8	28.0	82.0
1955	32.0	30.0	87.9
1956	34.2	32.1	94.1
1957	36.4	34.1	99.9
1958	38.9	36.5	106.9
1959	41.4	38.8	113.7
1960	43.8	41.1	120.4

a. From Table 9, p. 24, above.
b. For listing of products included, see Table 23, p. 58, above. On the basis of CIA estimates for 1951, it is estimated that this category is 93.8 percent of the rolled steel, shown in the first column of this table.
c. For listing of products included, see Table 23, p. 58, above. On the basis of US yield data, it is estimated that this category is approximately 2.93 times finished hot-rolled steel.

f. The production of hot- and cold-rolled steel coming from new units in each year (P_n) was computed by the formula $P_n=P_y-P_{y-1}$ (1+E), where P_y = the total production of hot- and cold-rolled steel in the current year; P_{y-1} = the total production of hot- and cold-rolled steel in the preceding year; and E = the percentage increase in the production (over the preceding year) of rolling mills operating in the preceding year.

g. The values of P_n so derived were multiplied by the equipment-output ratio (0.0191) to obtain the estimates of equipment requirements for new rolling mill units shown in Table 25.

Table 25

Estimated Nonelectrical Equipment Requirements for New Ferrous Rolling Mills in the USSR for 1951-60

Tons

Year	Production of Hot- and Cold-Rolled Steel (Million)	Production of Mills Operating in Preceding Year at Productivity of Current Year (Million)	Production from New Mills (Million)	Equipment Requirements for New Mills (Thousand)
1950	53.6	a/	a/	a/
1951	61.5	56.3	5.2	99.3
1952	68.9	64.6	4.3	82.1
1953	75.9	71.7	4.2	80.2
1954	82.0	78.2	3.8	72.6
1955	87.9	83.6	4.3	82.1
1956	94.1	88.8	5.3	101.2
1957	99.9	95.0	4.9	93.6
1958	106.9	100.9	6.0	114.6
1959	113.7	108.0	5.7	108.9
1960	120.4	114.8	5.6	107.0

a. Not applicable.

h. Replacement requirements for rolling mills were computed on the basis of information from a direct source. 120/ Equipment stocks (in tons) were determined for 1952 through 1960 by adding the weight of new equipment going into operation beginning with 1952 to the estimated stock for 1951.* A replacement rate of 7 percent per year was applied to the stock weights of the preceding year to estimate replacement requirements for each year.

* See Table 23, p. 58, above.

The resulting estimates are given in Table 26.

Table 26

Estimated Nonelectrical Equipment Replacement Requirements for Ferrous Rolling Mills in the USSR for 1951-60

Tons

Year	Stock (Thousand)	Requirements
1950	1,077.9	Not applicable
1951	1,177.2	75.5
1952	1,259.3	82.4
1953	1,339.5	88.2
1954	1,412.1	93.8
1955	1,494.2	98.8
1956	1,595.4	104.6
1957	1,689.0	111.7
1958	1,803.6	118.2
1959	1,912.5	126.3
1960	2,019.5	133.9

8. Estimates of Equipment Requirements for Steel Plant Service Divisions and Miscellaneous Items.

Equipment for general plant services and some miscellaneous items of equipment cannot be allocated to individual production divisions. Requirements were estimated on the basis of the increases in the production of crude steel by the following procedures:

a. US data 121/ relating equipment requirements to production were used to derive an over-all equipment-output ratio. The ratio is given in Table 27.*

* Table 27 follows on p. 63.

Table 27

Equipment-Output Relationships
for Steel Plant Service Divisions
and Miscellaneous Items in the US 122/

Equipment for:	Requirements (Tons per Million Tons of Ingot Capacity)
Pump houses	600
Railroads	6,060
Maintenance shops	1,670
Boiler and power houses	3,590
Distribution (electricity, gas, and the like)	1,620
Miscellaneous heating and annealing furnaces	20
Miscellaneous machinery	7,580
Total	21,140

b. The increments to total crude steel production from year to year were multiplied by the equipment-output ratio (Table 27) to determine the total service and miscellaneous equipment requirements for new capacity in each year. The results are given in Table 28.*

c. The stock of service and miscellaneous equipment in service in each year was estimated by the multiplication of the total equipment-output ratio** by the steel production for the same year. The replacement requirements for each year were computed at 5 percent of the stock of equipment existing in the preceding year. Average useful lives of individual types of equipment were taken from Bureau of Internal Revenue data. 123/ The replacement estimates are given in Table 29.***

* Table 28 follows on p. 64.
** See Table 27, above.
*** Table 29 follows on p. 65.

Table 28

Estimated New Nonelectrical Service and Miscellaneous Equipment Requirements for the Production of Steel in the USSR for 1951-60

Tons

Year	Steel Production a/ (Million)	Increment to Steel Production (Million)	Estimated New Service and Miscellaneous Equipment Requirements (Thousand)
1950	27.1	Not applicable	Not applicable
1951	31.2	4.1	86.7
1952	34.3	3.1	65.5
1953	37.7	3.4	71.9
1954	40.7	3.0	63.4
1955	43.7	3.0	63.4
1956	46.7	3.0	63.4
1957	49.7	3.0	63.4
1958	53.1	3.4	71.9
1959	56.5	3.4	71.9
1960	60.0	3.5	74.0

a. From Table 9, p. 24, above.

9. Estimates of Inputs for Production of Ferrous Metallurgical Equipment.

a. Estimated Inputs.

The estimated input requirements per unit of Soviet ferrous metallurgical equipment are given in Tables 30 and 31.* The procedures followed in calculating these inputs are described in b through e of this section.

* Tables 30 and 31 follow on pp. 66 and 68, respectively.

Table 29

Estimated Nonelectrical Service
and Miscellaneous Equipment Replacement Requirements
for the Production of Steel in the USSR
for 1951-60

Tons

Year	Steel Production (Million)	Stock (Thousand)	Replacements (Thousand)
1950	27.1	572.9	Not applicable
1951	31.2	659.6	28.6
1952	34.3	725.1	33.0
1953	37.7	797.0	36.3
1954	40.7	860.4	39.8
1955	43.7	923.8	43.0
1956	46.7	987.2	46.2
1957	49.7	1,050.7	49.4
1958	53.1	1,122.5	52.5
1959	56.5	1,194.4	56.1
1960	60.0	1,268.4	59.7

b. Estimates of the Weight of Metallurgical Equipment and the Percentage Distribution of Materials for Rolling Mills.

The weight data for rolling mills came from three major sources. 124/ One report has a detailed breakdown of inputs into 10 categories of rolling mills, and another has the total weight data for those listed.

c. Estimates of Labor Requirements in Man-Hours Per Ton for All Units.

A report obtained from a US manufacturer contains figures on the man-hours expended in machining, fitting, welding, and indirect labor for a 2-year period at a heavy equipment manufacturing plant. It also gives the dollar value of the machinery product shipped.*

* Continued on p. 70.

Table 30

Estimated Material Input Requirements Per Unit of Nonelectrical Ferrous Metallurgical Equipment in the USSR for 1951-55

Equipment	Weight of Finished Metallurgical Equipment per Unit (Tons)	Distribution of Finished Materials Per Unit (Percent)					
		Iron Castings	Steel Castings	Nonferrous Casting and Rolled Items	Steel Forgings	Fabricated Rolled Steel	Others
Blast furnace, 600-cubic-meter	2,230	40.5	26.4	0.7	3.6	22.2	6.6
Blast furnace, 1,000-cubic-meter	3,000	44.8	25.4	0.2	3.5	19.6	6.5
Blast furnace, 1,300-cubic-meter	3,650	43.5	26.4	0.2	2.9	20.7	5.3
Martin furnace, 70-ton capacity	929	23.2	37.6	1.2	9.9	26.3	1.8
Martin furnace, 150-ton capacity	1,302	23.2	37.6	1.2	9.9	26.4	1.7
Martin furnace, 350-ton capacity	2,007	23.2	37.6	1.2	9.9	26.4	1.7
Coke battery, 65 ovens	1,383	56.5	7.4	0.4	2.8	29.0	3.9
Crushing and agglomerating equipment for a 600-cubic-meter blast furnace operating on lean ores	632	38.4	14.3	0.2	14.3	28.2	4.6
Crushing and agglomerating equipment for a 1,000-cubic-meter blast furnace operating on lean ores	1,240	37.5	16.6	0.2	14.5	27.6	3.6
Crushing and agglomerating equipment for a 1,300-cubic-meter blast furnace operating on lean ores	1,405	37.0	19.0	0.2	14.4	24.6	4.8
Blooming mill	8,650	3.0	41.0	1.7	20.0	34.0	0.3
Billet mill (continuous)	1,910	13.5	51.5	1.7	10.0	23.0	0.3
Tube-round mill	4,010	19.5	42.0	2.5	13.5	22.0	0.5
Rod mill	1,320	15.0	26.5	1.3	17.5	39.0	0.7
Skelp mill	1,340	14.0	30.0	1.4	10.0	44.0	0.6
Light structural mill	4,670	33.0	34.0	2.0	11.0	20.0	Negligible
Sheared plate mill	6,230	19.0	40.5	2.2	12.0	26.0	0.3

Table 30

Estimated Material Input Requirements Per Unit of Nonelectrical Ferrous Metallurgical Equipment in the USSR for 1951-55
(Continued)

Equipment	Weight of Finished Metallurgical Equipment per Unit (Tons)	Distribution of Finished Materials Per Unit (Percent)					
		Iron Castings	Steel Castings	Nonferrous Casting and Rolled Items	Steel Forgings	Fabricated Rolled Steel	Others
Sheet mill (continuous)	43,300	10.5	57.0	2.7	14.5	15.0	0.3
Rail mill	15,010	27.0	48.5	1.6	16.5	5.0	1.4
Bar mill	3,210	33.0	34.0	2.0	11.0	20.0	Negligible
Wire mill	5,830	17.5	38.0	1.8	12.5	30.0	0.2
Heavy structural mill	18,530	27.0	48.5	1.6	16.5	5.0	1.4
Seamless tube mill	4,060	42.0	10.5	1.1	8.0	32.0	6.4
Wheel mill	2,940	19.5	42.0	2.5	13.5	22.0	0.5
Welded pipe mill	3,620	42.0	10.5	1.1	8.0	32.0	6.4
Universal plate mill	4,760	19.0	40.5	2.2	12.0	26.0	0.3
Sheet mill (noncontinuous)	10,160	9.5	61.0	3.1	10.5	15.0	0.9
Cold strip mill	2,110	0.5	64.5	3.1	6.5	25.0	0.4
Strip mill (tinplate widths)	16,560	9.5	61.0	3.1	10.5	15.0	0.9
Strip mill (narrow)	4,950	9.5	61.0	3.1	10.5	15.0	0.9
Average, all rolling mills	a/	19.5	42.0	2.5	13.5	22.0	0.5
Service divisions and miscellaneous	a/	26.9	38.9	1.0	11.2	22.0	a/
Average, all equipment	a/	25.8	37.4	1.6	10.8	23.0	1.4

a. Not applicable.

Table 31

Estimated Service Input Requirements Per Unit of Nonelectrical Ferrous Metallurgical Equipment in the USSR a/* for 1951-55

Equipment	Total Manufacturing Labor			Field Erection Labor (Man-Hours per Ton)	Machine Tool Hours (Hours per Ton)	Electric Power (Kilowatt-Hours per Ton)
	Productive Labor (Man-Hours per Ton)	Indirect Labor (Man-Hours per Ton)	Total Labor (Man-Hours per Ton)			
Blast furnace, 600-cubic-meter	105.45	100.95	205.40	19.65	24.79	
Blast furnace, 1,000-cubic-meter	105.45	100.95	205.40	19.65	24.79	
Blast furnace, 1,300-cubic-meter	105.45	100.95	205.40	19.65	24.79	
Martin furnace, 70-ton capacity	105.90	101.40	207.30	21.00	25.09	
Martin furnace, 150-ton capacity	105.90	101.40	207.30	21.00	25.09	
Martin furnace, 350-ton capacity	105.90	101.40	207.30	21.00	25.09	
Coke battery, 65 ovens	105.45	100.95	205.40	22.35	24.79	
Crushing and agglomerating equipment for a 600-cubic-meter blast furnace operating on lean ores	105.45	100.95	205.40	21.00	24.79	
Crushing and agglomerating equipment for a 1,000-cubic-meter blast furnace operating on lean ores	105.45	100.95	205.40	21.00	24.79	
Crushing and agglomerating equipment for a 1,300-cubic-meter blast furnace operating on lean ores	105.45	100.95	205.40	21.00	24.79	
Blooming mill	96.75	91.95	188.70	20.85	29.48	
Billet mill (continuous)	171.15	162.90	334.05	31.65	25.30	
Tube-round mill	126.00	119.70	245.70	24.75	25.30	
Rod mill	268.50	255.00	523.50	35.40	53.86	
Skelp mill	378.00	360.00	738.00	28.50	26.83	
Light structural mill	90.90	86.40	177.30	18.60	40.39	
Sheared plate mill	103.05	97.95	201.00	21.75	31.01	

* Footnote for Table 31 follows on p. 69.

Table 31

Estimated Service Input Requirements Per Unit of Nonelectrical Ferrous Metallurgical Equipment in the USSR a/ for 1951-55
(Continued)

Equipment	Total Manufacturing Labor			Field Erection Labor (Man-Hours per Ton)	Machine Tool Hours (Hours per Ton)	Electric Power (Kilowatt-Hours per Ton)
	Productive Labor (Man-Hours per Ton)	Indirect Labor (Man-Hours per Ton)	Total Labor (Man-Hours per Ton)			
Sheet mill (continuous)	80.00	102.75	210.75	22.50	21.32	
Rail mill	103.80	98.55	202.35	20.55	32.03	
Bar mill	204.30	193.20	396.00	32.25	40.39	
Wire mill	357.00	339.00	696.00	43.80	26.83	
Heavy structural mill	99.45	94.50	193.95	16.20	32.03	
Seamless tube mill	309.75	294.75	604.50	40.50	26.83	
Wheel mill	169.50	161.25	330.75	27.60	26.83	
Welded pipe mill	313.50	298.50	612.00	40.65	26.83	
Universal plate mill	102.45	97.50	199.95	21.90	31.01	
Sheet mill (noncontinuous)	136.05	129.45	265.50	24.90	26.83	
Cold strip mill	399.00	379.50	778.50	126.15	21.11	
Strip mill (tinplate widths)	124.80	118.65	243.45	24.00	23.87	
Strip mill (narrow)	94.95	90.30	185.25	25.80	23.87	
Average, all rolling mills	130.95	124.50	255.45	33.45	26.83	
Service divisions and miscellaneous	213.15	163.50	376.65	58.35	43.66	
Average, all equipment	145.00	127.51	272.51	35.10	30.71	732.0

a. Labor and machine tool hour inputs are based on US practice. To convert machine tool hours to Soviet practice, 2 percent was added to US input requirements. To convert labor man-hours to Soviet practice, 50 percent was added to US input requirements.

The labor for machining, fitting, and welding is designated the total productive labor; dividing this by the value of the product shipped gives the total productive labor per dollar of product shipped.

The report also gives the weight of 10 types of rolling mills and their value in dollars. Dividing total value by total weight yields the dollars per ton for rolling mills.

If these two derived values are multiplied together, the product is the total productive labor required for the manufacture of a ton of product.

The same procedure was followed to obtain the machining and fitting hours required for the manufacture of one ton of product, and the relationship between the machining and fitting hours per ton and the total productive labor per ton was calculated.

25X1A5a1 From the [redacted] it was possible to derive figures for the machining and fitting hours per ton for each major unit of metallurgical equipment. By applying the relationship of total productive labor per ton and the machining and fitting labor per ton to each major unit, the figures for the total productive labor were obtained. The US manufacturer's report also gave the amount of indirect labor expended, and a similar relationship was found for indirect labor per ton and applied to all units.

The total manufacturing labor required per ton of equipment is merely the addition of the total productive labor per ton and the indirect labor per ton.

The figures for the labor required for erection per ton were
25X1A5a1 obtained from the [redacted]

d. Estimates of the Machine Tool Hours Required per Ton of Equipment.

For each of the 10 rolling mills of the US manufacturer's report, values were given for the machine tool hours. From these were calculated the machine tool hours per ton for each mill and a weighted value of machine tool hours per ton.

Where possible, these values were applied to the specific mills and mills of a similar nature. For the rest of the rolling mills, the weighted value is given.

For all other metallurgical units the relationship of the total productive labor per ton and the machine tool hours per ton was found for rolling mills and applied to the other units.

e. Estimate of Electric Power Requirements per Ton of Metallurgical Equipment Produced.

The US manufacturer's report gave figures for the kilowatt-hours of electric power expended by the heavy machine-building plant. Following the procedure for finding the total productive labor per ton, a value was obtained for the electric power required in kilowatts per ton.

APPENDIX D

GAPS IN INTELLIGENCE

Some specific gaps follow in intelligence on ferrous metallurgical equipment in the USSR:

1. Information concerning the manufacture, installation, and design of metallurgical equipment.

2. Trade data.

3. Accurate input data on US furnaces, cranes, coke ovens, and a few of the special rolling mills are required.

4. Information on the number of physical units, blast furnaces, Martin furnaces, and the like, installed each year.

5. Information on the units in operation.

6. An accurate definition of the term metallurgical equipment as used by Soviet authorities.

7. Information on the administrative organization of the Ministry of Heavy Machine Building.

8. Physical description of and economic information concerning metallurgical equipment in all of the Satellites.

APPENDIX E

SOURCE REFERENCES

Soviet technical literature and newspapers are the most reliable and up-to-date sources of information. Soviet materials at the Library of Congress, FDD reports and translations, [redacted] 25X1X7 [redacted] FBIS reports, and Treasure Island reports were found to be extremely valuable.

The raw intelligence sources used are given an over-all evaluation of RR 2.

References to the CIA Industrial Register studies are the result of scanning pertinent documents of some 300 plant consolidations, which include many types of intelligence reports. Reports from the Soviet press were the most reliable and up-to-date. Prisoner-of-war reports were in most cases of little value.

Three sources used in this report to a considerable extent and not previously mentioned were a Russian metallurgical engineer who specialized in furnace design, erection, and operation; [redacted] re- 25X1A5a1 ports; and information from a US manufacturer of metallurgical equipment.

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this report. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

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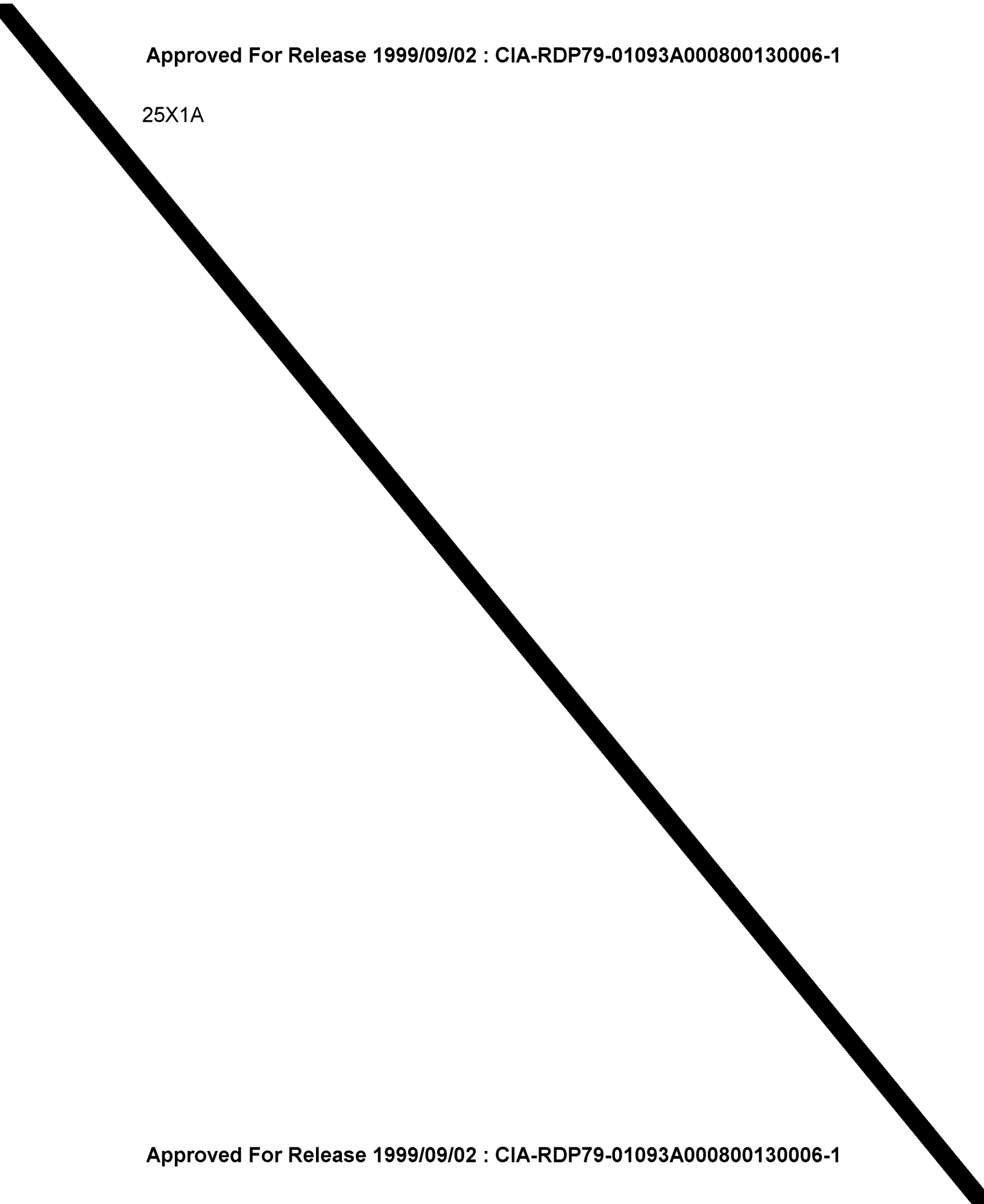

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